

OPERATING MANUAL

SYNTHESIZER/ FUNCTION GENERATOR 3325A





HEWLETT
PACKARD

OPERATING MANUAL

MODEL 3325A SYNTHESIZER/FUNCTION GENERATOR

Serial Number 1748A00101

IMPORTANT NOTICE

This manual applies to instruments with the above serial number and greater. Any changes made after this manual was printed will be shown on a Manual Changes Supplement included with this manual.

WARNING

To prevent potential fire or shock hazard, do not expose equipment to rain or moisture.

Manual Part No. 03325-90012

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CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment [except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period] . During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.



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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

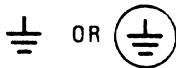
General Definitions of Safety Symbols Used On Equipment or In Manuals.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.



Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.



Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Alternating current (power line).



Direct current (power line).



Alternating or direct current (power line).

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE :

The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The Operating and Service Manual contains information required to install, operate, test, adjust, and service the Hewlett-Packard Model 3325A Synthesizer/-Function Generator. The Operating Information Supplement is a copy of the first four sections of the Operating and Service Manual. It also includes the Operational Verification procedures from Section IV, which may be used for incoming inspection. The supplement should be kept with the instrument for use by the operator. The part numbers of both the Operating and Service Manual and the Operating Information Supplement are shown on the title pages.

1-3. Also shown on the title page of this manual is a Microfiche part number. This number can be used to order 4 × 6 inch transparencies of the Operating and Service Manual. Each Microfiche contains up to 96 photo-duplicates of the manual pages. The Microfiche package includes the latest Manual Changes supplement as well as pertinent Service Notes.

1-4. Additional copies of the Operating and Service Manual, Operating Information Supplement, or Service Notes can be ordered through your nearest Hewlett-Packard Sales and Service Office. (A list of these offices is provided at the end of this manual.)

1-5. INSTRUMENT DESCRIPTION.

1-6. The Model 3325A Synthesizer/Function Generator produces the following signals at a minimum frequency of 1 μ Hz and maximum frequency of:

Sine wave	20 MHz
Square wave	10 MHz
Triangle	10 kHz
Positive slope ramp	10 kHz
Negative slope ramp	10 kHz

Frequency may be selected with up to eleven digits of resolution. Output amplitude is 1 mV to 10 V peak-to-peak. The output level may also be selected or displayed in V rms or in dBm (50 ohms). Any function may be dc offset up to ± 4.5 V, or the output may be dc only up to ± 5 V. An optional high voltage output produces up to 40 V p-p into ≥ 500 ohms load.

1-7. Frequency sweep of all functions is provided in linear or log sweep, at sweep times of 10 milliseconds to 99.99 seconds for linear sweep. Maximum time for log sweep is 99.99 seconds and minimum time is 2 seconds for single log sweep and 0.1 second for continuous log sweep. Single linear sweep may be up or down, while continuous sweep is up/down/up, etc., in the linear mode and up/up, etc., in log mode.

1-8. The Model 3325A is fully programmable through the rear panel Hewlett-Packard Interface Bus (HP-IB) connector. A device such as a programmable calculator is capable of remotely controlling the 3325A. Interface information is given in Section II of this manual, and programming information is in Section III.

1-9. SPECIFICATIONS.

1-10. Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Any changes in specifications due to manufacturing, design or traceability to the U.S. National Bureau of Standards are included in Table 1-1 of this manual and/or the Manual Changes Supplement. Specifications listed in this manual supersede all previous specifications for the Model 3325A.

1-11. SUPPLEMENTAL OPERATING INFORMATION.

1-12. Table 1-2 contains information describing general operating characteristics of the 3325A. This information is supplemental operating information and is not to be considered as specifications.

1-13. REMOTE CONTROL.

1-14. Table 1-3 lists the HP-IB interface capabilities of the Model 3325A in conformity with IEEE Standard 488-1975, "Standard Digital Interface for Programmable Instrumentation". HP-IB response times are given in Table 1-4.

1-15. OPTIONS.

1-16. The following options extend the frequency stability and output amplitude capabilities of the Model 3325A:

Option 001	High Stability Frequency Reference
Option 002	High Voltage Output

The following options indicate the line voltage to which the instrument was set at the factory:

Option 100	Nominal 100 V ac
Option 120	Nominal 120 V ac
Option 220	Nominal 220 V ac
Option 240	Nominal 240 V ac

Table 1-1. Specifications.

FUNCTIONS AND FREQUENCIES		AMPLITUDE													
Sine Wave: Signal Output (Front or Rear Panel): 0.000 001 Hz to 20 999 999.999 Hz Auxiliary Output (Rear Panel): 21 000 000.000 Hz to 60 999 999.999 Hz Underrange to 19 000 000.001 Hz Square Wave: 0.000 001 Hz to 10 999 999.999 Hz Triangle: 0.000 001 Hz to 10 999.999 999 Hz Positive and Negative Slope Ramp: 0.000 001 Hz to 10 999.999 999 Hz		Amplitude Accuracy with no Attenuation (Attenuator range 1) into 50 ohm Load. (No D.C. offset)													
FREQUENCY RESOLUTION		Function and frequency range	Tolerance relative to programmed amplitude												
1 μHz for frequencies below 100 kHz 1 mHz for frequencies 100 kHz and higher		Sine Wave .001 Hz to 100 kHz	± 0.1 dB												
FREQUENCY ACCURACY (Standard Instrument)		Square Wave .001 Hz to 100 kHz	± 1.0%												
± 5 × 10 ⁻⁶ of selected value (20° to 30°C)		Triangle .001 Hz to 2 kHz 2 kHz to 10 kHz	± 1.5% ± 5%												
FREQUENCY STABILITY (Standard Instrument)		Ramps .001 Hz to 500 Hz 500 Hz to 10 kHz	± 1.5% ± 10%												
± 5 × 10 ⁻⁶ per year (20° to 30°C)		Flatness with no attenuation (Attenuator Range 1) into a 50 Ohm load	Tolerance relative to programmed amplitude at 1 kHz												
SIGNAL CHARACTERISTICS		Sine Wave 100 kHz to 20 MHz	± 0.3 dB												
Sine Wave: Harmonic Distortion relative to the amplitude of the fundamental frequency at full output on each range		Square Wave 100 kHz to 10 MHz	± 10%												
<table><tr><th>Fundamental Frequency</th><th>No Harmonic Greater Than</th></tr><tr><td>0.1 Hz to 50 kHz</td><td>- 65 dB</td></tr><tr><td>50 kHz to 200 kHz</td><td>- 60 dB</td></tr><tr><td>200 kHz to 2 MHz</td><td>- 40 dB</td></tr><tr><td>2 MHz to 15 MHz</td><td>- 30 dB</td></tr><tr><td>15 MHz to 20 MHz</td><td>- 25 dB</td></tr></table>		Fundamental Frequency	No Harmonic Greater Than	0.1 Hz to 50 kHz	- 65 dB	50 kHz to 200 kHz	- 60 dB	200 kHz to 2 MHz	- 40 dB	2 MHz to 15 MHz	- 30 dB	15 MHz to 20 MHz	- 25 dB	Amplitude accuracy with D.C. offset and no attenuation (Range 1) into a 50 ohm load.	Tolerance relative to programmed amplitude.
Fundamental Frequency	No Harmonic Greater Than														
0.1 Hz to 50 kHz	- 65 dB														
50 kHz to 200 kHz	- 60 dB														
200 kHz to 2 MHz	- 40 dB														
2 MHz to 15 MHz	- 30 dB														
15 MHz to 20 MHz	- 25 dB														
Spurious: All non-harmonically related output signals will be more than 70 dB below the carrier or less than - 90 dBm, whichever is greater.		Sine Wave .001 Hz to 100 kHz	± 0.3 dB												
Phase Noise: ≥ - 60 dB for a 30 kHz band centered on a 20 MHz carrier (excluding ± 1 Hz about the carrier)		Square .001 Hz to 100 kHz	± 3%												
Square Wave: Rise/Fall Time: < 20 nanoseconds, 10% to 90% at full output		Triangle .001 Hz to 2 kHz 2 kHz to 10 kHz	± 4% ± 6%												
Symmetry: < 0.1% of period + 3 nanoseconds		Ramps .001 Hz to 500 Hz 500 Hz to 10 kHz	± 4% ± 11%												
Overshoot: < 5% of peak amplitude at full output		Attenuator Accuracy (these errors are additive with the amplitude accuracy errors)	Tolerance relative to programmed amplitude.												
Triangle: Linearity, 10% to 90%, best fit straight line: ± 0.05% of full output for each range, measured with a 20 MHz low pass filter.		.001 Hz to 20 kHz Attenuator Range 1	No Error												
Ramps (Positive or Negative Slope): Linearity, 10% to 90%, best fit straight lint: ± 0.05% fo full output for each range, measured with a 20 MHz low pass filter.		.001 Hz to 100 kHz Attenuator ranges 2 through 8	± 0.1 dB												
Retrace Time: < 3 microseconds, 90% to 10%		100 kHz to 10 MHz Attenuator ranges 2 through 8	± 0.2 dB												
Ramp Period Variation: < ± 1% of period, maximum		10 MHz to 20 MHz Attenuator ranges 2 through 4 Attenuator ranges 5 through 8	± 0.2 dB ± 0.5 dB												

Table 1-1. Specifications (Cont'd).

Accuracy of DC Offset (into 50 ohms): DC Only (No AC Function): $\pm 0.4\%$ of full output for each range*	Aging Rate: $\pm 5 \times 10^{-8}$ per week (after 72 hours continuous operation) $\pm 1 \times 10^{-7}$ per month (after 15 days continuous operation)								
*Except lowest attenuator range where accuracy is $\pm 20 \mu\text{V}$.									
DC + AC, $\leq 1 \text{ MHz}$: $\pm 1.2\%$, Ramps $\pm 2.4\%$	OPTION 002								
DC + AC, $> 1 \text{ MHz}$: $\pm 3\%$	HIGH VOLTAGE OUTPUT								
AMPLITUDE MODULATION (of Sine Function only)	Frequency Range: Sine and Square Wave: $1 \mu\text{Hz}$ to 1 MHz Triangle and Ramps: $1 \mu\text{Hz}$ to 10 kHz								
Modulation Envelope Distortion: -30 dB to 80% modulation at 1 kHz , 0 V dc Offset									
PHASE OFFSET	Amplitude: Range: 4 mV p-p to 40 V p-p ($\geq 500 \Omega$, $< 500 \text{ pF}$ load) maximum output current, 40 mA p-p								
Range: $\pm 719.9^\circ$ with respect to arbitrary starting phase, or assigned zero phase	Accuracy (at 2 kHz): $\pm 2\%$ of full output for each range								
Resolution: 0.1° Stability: $\pm 1^\circ \text{ phase}/^\circ\text{C}$ Increment Accuracy: $\pm 0.2^\circ$	Flatness: $\pm 10\%$ of programmed amplitude								
PHASE MODULATION	DC Offset: Range: 4 times the range of the standard instrument								
Linearity (Sine Function): $\pm 0.5\%$, best fit straight line	Accuracy: $\pm (1\% + 25 \text{ mV})$ of full output for each range								
SYNC OUTPUT	Signal Characteristics: Sine Wave Harmonic Distortion (relative to the fundamental frequency at full output into $\geq 500 \text{ ohms}$, $< 500 \text{ pF}$)								
Output Levels into 50 ohms : Square wave with $V_{\text{high}} > +1.2 \text{ V}$, $V_{\text{low}} < +0.2 \text{ V}$	<table> <tr> <th>Fundamental Frequency</th><th>No Harmonic Greater Than</th></tr> <tr> <td>10 Hz to 50 kHz</td><td>-65 dB</td></tr> <tr> <td>50 kHz to 200 kHz</td><td>-60 dB</td></tr> <tr> <td>200 kHz to 1 MHz</td><td>-40 dB</td></tr> </table>	Fundamental Frequency	No Harmonic Greater Than	10 Hz to 50 kHz	-65 dB	50 kHz to 200 kHz	-60 dB	200 kHz to 1 MHz	-40 dB
Fundamental Frequency	No Harmonic Greater Than								
10 Hz to 50 kHz	-65 dB								
50 kHz to 200 kHz	-60 dB								
200 kHz to 1 MHz	-40 dB								
X DRIVE OUTPUT									
Amplitude: 0 to $+10 \text{ V}$ dc linear ramp proportional to sweep frequency (sweep up only)									
Linearity, 10% to 90% , best fit straight line: $\pm 0.1\%$ of final value. Specified for all linear sweep widths which are integral multiples of the minimum sweep width for each function and sweep time.									
OPTION 001	Square Wave: Rise/Fall Time: $< 100 \text{ nanoseconds}$, 10% to 90% at full output with $\geq 500 \text{ ohm}$, $< 500 \text{ pF}$ load								
HIGH STABILITY FREQUENCY REFERENCE	Overshoot: $< 10\%$ of peak amplitude with $\geq 500 \text{ ohm}$, $< 500 \text{ pF}$ load								
Ambient Stability: $\pm 5 \times 10^{-8}$ (0° to 55°C referenced to $+30^\circ\text{C}$)									

Table 1-2 Supplemental Information

MAIN SIGNAL OUTPUT	4	30	299.9 mV to 100.0 mV
	5	100	99.99 mV to 30.00 mV
50 Ω Impedance	6	300	29.99 mV to 10.00 mV
	7	1000	9.999 mV to 3.000 mV
BNC Connector, switchable to front or rear panel (not switchable with Option 002)	8	3000	2.999 mV to 1.000 mV

May be floated a maximum of ±42 V peak (ac + dc) from chassis (earth) ground

Amplitude Ranges:
All AC Functions (with no dc offset):

Range No.	Attenuation Factor	Amplitude (Peak-to-Peak)
1	1	10.00 V to 3.000 V
2	3	2.999 V to 1.000 V
3	10	999.9 mV to 300.0 mV

DC Offset Only:

Range No.	Attenuation Factor	Amplitude (Peak-to-Peak)
1	1	5.000 V to 1.500 V
2	3	1.499 V to 500.0 mV
3	10	499.9 mV to 150.0 mV
4	30	149.9 mV to 50.00 mV
5	100	49.99 mV to 15.00 mV
6	300	14.99 mV to 5.000 mV
7	1000	4.999 mV to 1.500 mV
8	3000	1.499 mV to 1.000 mV

Table 1-2. Supplemental Information (Cont'd).

AC Function with DC Offset:

Range No.	Attenuation Factor	AC Function Amplitude (p-p)	Maximum DC (+ or -)	Min. DC (+ or -)
1	1	9.998 V to 1.000 V	1.000 mV to 4.500 V	1.000 mV
2	3	999.9 mV to 333.4 mV	1.166 V to 1.499 V	0.100 mV
3	10	333.3 mV to 100.0 mV	333.3 mV to 450.0 mV	0.100 mV
4	30	99.99 mV to 33.34 mV	116.6 mV to 149.9 mV	0.010 mV
5	100	33.33 mV to 10.00 mV	33.33 mV to 45.00 mV	0.010 mV
6	300	9.999 mV to 3.334 mV	11.66 mV to 14.99 mV	0.001 mV
7	1000	3.333 mV to 1.000 mV	3.333 mV to 4.500 mV	0.001 mV

High Voltage Output Option 002:

Amplitude and Ranges: 4 times the standard instrument amplitudes

Output Impedance: $< 2 \Omega$ at DC to $< 10 \Omega$ at 1 MHz

Square Wave Settling Time: $< 1 \mu\text{s}$ to settle to within .05% of final value for frequencies of 10 Hz to 500 kHz, tested at full output with no load

FREQUENCY SWEEP

Sweep Time:

Linear Sweep: 0.01 second to 99.99 seconds (single or continuous)

Log Sweep:

Single Sweep: 2 seconds to 99.99 seconds
Continuous Sweep: 0.1 second to 99.99 seconds

Maximum Sweep Width: 1 Hz to maximum frequency of the function selected

Minimum Sweep Width (Linear):

Minimum Sweep Width

Function	Sweep Time 0.01 second	Sweep Time 99.99 seconds
Sine	0.1 mHz	999.9 mHz
Square	0.05 mHz	499.5 mHz
Triangle	0.005 mHz	49.95 mHz
Ramps	0.01 mHz	99.99 mHz

Minimum Sweep Width (Log): 1 decade

Phase Continuity: Sweep is phase continuous over the full frequency range

WARMUP TIME

Standard Instrument: 20 minutes to within specified accuracy

Option 001 High Stability Frequency Reference:

Reference will be within $\pm 1 \times 10^{-7}$ of final value 15 minutes after turn-on at 25°C for an off time of less than 24 hours

AUXILIARY INPUTS (May be floated a maximum of ± 42 V peak (ac + dc) from chassis [earth] ground)

Reference: For phase-locking the 3325A to an external frequency reference of 10 MHz or a subharmonic of 10 MHz down to 1 MHz. Level must be 0 dBm to +20 dBm into 50 ohms. Rear panel BNC connector.

Amplitude Modulation Input (Sine Function Only):

Modulation depth at full output for each range:
0 to 100%

Modulation frequency range: DC to 500 kHz (0 to 21 MHz carrier frequency)

Sensitivity: 5 V peak for 100% modulation

Input Impedance: 10 k Ω

Connector: Rear panel BNC

Phase Modulation:

Modulation Frequency Range: DC to 5 kHz

Modulation Depth

Function	Depth (+ or -)
Sine	850°
Square	425°
Triangle	42.5°
Ramps	85°

Input Impedance: 20 k Ω

Connector: Rear panel BNC

AUXILIARY OUTPUTS (May be floated a maximum of ± 42 V peak (ac + dc) from chassis [earth] ground)

Auxiliary Frequency Output (ac coupled output):

Frequency Range: 21 MHz to 60.999 999 999 MHz, with underrange coverage to 19.000 000 001 MHz

Amplitude: 0 dBm

Output Impedance: 50 ohms

Connector: Rear panel BNC

1 MHz Reference Output (for phase-locking other instruments to 3325A):

Amplitude: 0 dBm

Output Impedance: 50 ohms

Connector: Rear panel BNC

Marker Output (Linear sweep only):

Levels: High to Low TTL compatible voltage transition at selected marker frequency, sweep up only.

Connector: Rear panel BNC

Table 1-2. Supplemental Information (Cont'd).

X Drive Output (Sweep up only): Amplitude: 0 to + 10 V linear ramp proportional to sweep frequency Connector: Rear panel BNC Z Blank Output: Levels (TTL compatible voltage levels): Linear Sweep: Single: Low at start of sweep, High at stop. Remains High until start of next sweep. Continuous: Low during sweep up, High during sweep down. Log Sweep: Single: Low at start of sweep, High at stop. Remains High until start of next sweep. Continuous: Low during sweep. Goes High momentarily at stop frequency. 10 MHz Oven Reference Output, Option 001, for phase locking the 3325A to the optional high stability frequency reference: Amplitude: 0 dBm, 50 ohms Connector: Rear panel BNC. Must be connected to the rear panel EXT REF IN connector. REMOTE CONTROL Hewlett-Packard Interface Bus (HP-IB) Control: (HP-IB is Hewlett-Packard Company's implementation of IEEE Standard 488-1975). Time shown is in addition to programming time.	Frequency Switching and Settling Time: * < 10 ms to within 1 Hz of final value for 100 kHz span < 25 ms to within 1 Hz of final value for 1 MHz span < 70 ms to within 1 Hz of final value for 20 MHz span Phase Switching and Settling Time: * < 15 ms to within 90° of phase lock for 20 MHz frequency change Amplitude Switching Time: * < 30 ms to within amplitude specifications *Times shown are in addition to programming time GENERAL Operating Environment: Temperature: 0° to 55°C Relative Humidity: < 95%, 0° to 40°C Altitude: ≤ 15,000 ft. Storage Temperature: -50° to +75°C Storage Altitude: ≤ 50,000 ft. Power Requirements: 100/120/220/240V + 5%, - 10%, 48 to 66 Hz 60 VA, 100 VA with all options, 10 VA standby Dimensions in millimeters and (inches): 132.6 (5¼) high × 425.5 (16¾) wide × 497.8 (19-5/8) deep Weight in kilograms and (lbs): Net weight: 9(20) Shipping Weight: 14.5 (32)
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The following accessory options are also available for the Model 3325A:

Option 907	Front Handle Assembly
Option 908	Rack Mount Flange Kit
Option 909	Rack Mount Flange Kit/Front Handle Assembly
Option 910	Additional Operating and Service Manual

1-17. ACCESSORIES SUPPLIED.

1-18. A special connector is supplied with the High Stability Frequency Reference Option 001 for connecting the rear panel Reference Output to the Reference Input. This connector is Part No. 1250-1499.

1-19. ACCESSORIES AVAILABLE.

1-20. The following accessories are available for use with the Model 3325A:

Number	Description
11048C	50 ohm Feedthru Termination
11356A	Ground Isolator
03325-80001	Oven Board Assy. (Converts 3325A to Option 001)
03325-80002	High Voltage Option (Converts 3325A to Option 002)
5061-0077	Rack Mount Flange Kit (Option 908)
5061-0083	Rack Mount Flange/Front Handle Kit (Option 909)
5061-0089	Front Handle Kit (Option 907)

1-21. INSTRUMENT AND MANUAL IDENTIFICATION.

1-22. The instrument serial number is located on the rear panel. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix. A letter between the prefix and suffix identifies the country in which the instrument was manufactured (A = USA, G = West Germany, J = Japan, U = United Kingdom). All correspondence with Hewlett-Packard concerning this instrument should include the complete serial number.

1-23. The serial number prefix is the same for all identical instruments and changes only when a change is made to the instrument. The suffix is assigned sequentially and is different for each instrument. If the serial number of your instrument is lower than the serial number on the title page of this manual, refer to Section VII, MANUAL CHANGES, for the information that will adapt this manual to your instrument. This is especially important if the serial prefix of your instrument is different than the one shown on the title page of this manual. An instrument manufactured after the printing of this manual may differ in some respect from the information in this manual. In this case, a yellow Manual Changes supplement included with the manual explains how to adapt the manual to your instrument.

1-24. SAFETY CONSIDERATIONS.

1-25. To ensure safe operation and to retain the instrument in a safe condition, this Operating and Service Manual contains information, cautions and warnings which must be adhered to by the user or service personnel.

Table 1-3. HP-IB Interface Capability.

Code	Function
SH1	Source handshake capability
AH1	Acceptor handshake capability
T6	Basic talker; Serial poll; Unaddressed to talk if addressed to listen
L3	Basic listener; Listen only; Unaddressed to listen if addressed to talk
SR1	Service Request capability
RL1	Remote/Local capability
PP0	No parallel poll capability
DC1	Device Clear capability
DT0	No device trigger capability
C0	No controller capability
E1	Open collector bus drivers

1-26. The symbol ! appearing on the front or rear panel of the 3325A is an international symbol meaning "refer to the Operating and Service Manual". The symbol identifies important instructions required to prevent damage to the instrument. To ensure the safety of the operating and maintenance personnel and retain the safe operating condition of the instrument, these instructions must be adhered to.

1-27. RECOMMENDED TEST EQUIPMENT.

1-28. Equipment required to maintain the Model 3325A is listed in Table 1-5. Other equipment can be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-4. HP-IB Response Times.

Function	Mnemonic	Input Data Transfer Time	Device Time	Output Data Transfer Time
Function (Waveform) 1 Digit	FU	450–500 μ s 225–250 μ s	1600 ms 2.8 ms	450–500 μ s 225–250 μ s
Frequency ≤ 11 Digits + Decimal Delimiters	FR HZ, KH, or MH	450–500 μ s 225–250 μ s each 450–500 μ s	7.0 ms 2.8 ms each 12.5 ms	450–500 μ s 225–250 μ s each 450–500 μ s
Amplitude ≤ 4 Digits + Decimal Delimiters	AM VO or MV VR or MR DB	450–500 μ s 225–250 μ s each 450–500 μ s 450–500 μ s 450–500 μ s	6.8 ms 2.8 ms each 90 ms 130 ms 250 ms	450–500 μ s 225–250 μ s each 450–500 μ s 450–500 μ s 450–500 μ s
DC Offset ≤ 4 Digits + Decimal Delimiters	OF VO or MV	450–500 μ s 225–250 μ s each 450–500 μ s	6.8 ms 2.8 ms each 82 ms	450–500 μ s 225–250 μ s each 450–500 μ s
Phase ≤ 4 Digits + Decimal Delimiter	PH DE	450–500 μ s 225–250 μ s each 450–500 μ s	5 ms 2.8 ms each 28 ms	450–500 μ s 225–250 μ s each 450–500 μ s
Sweep Start Frequency ≤ 11 Digits + Decimal Delimiters	ST HZ, KH, or MH	450–500 μ s 225–250 μ s each 450–500 μ s	7.0 ms 2.8 ms each 10.3 ms	450–500 μ s 225–250 μ s each 450–500 μ s
Sweep Stop Frequency ≤ 11 Digits + Decimal Delimiters	SP HZ, KH or MH	450–500 μ s 225–250 μ s each 450–500 μ s	7.0 ms 2.8 ms each 10.3 ms	450–500 μ s 225–250 μ s each 450–500 μ s
Sweep Marker Frequency ≤ 11 Digits + Decimal Delimiters	MF HZ, KH or MH	450–500 μ s 225–250 μ s each 450–500 μ s	7.0 ms 2.8 ms each 10.3 ms	450–500 μ s 225–250 μ s each 450–500 μ s
Sweep Time ≤ 4 Digits + Decimal Delimiter	T1 SE	450–500 μ s 225–250 μ s each 450–500 μ s	5.5 ms 2.8 ms each 7.0 ms	450–500 μ s 225–250 μ s each 450–500 μ s
Store	SR	450–500 μ s	11 ms	
Recall	RE	450–500 μ s	1700 ms	
Assign Zero Phase	AP	450–500 μ s	5.2 ms	
Amptd Cal	AC	450–500 μ s	1500 ms	
Start Single Sweep	SS	450–500 μ s	300 ms	
Start Continuous Sweep	SC	450–500 μ s	300 ms	
Interrogate (Add Parameter Mnemonic Time)	I	225–250 μ s	3 ms	
Mask Service Request	MS	450–500 μ s	4.5 ms	
High Voltage Output	HV	450–500 μ s	48 ms	
Rear/Front Output	RF	450–500 μ s	44.5 ms	
Self Test	TE	450–500 μ s	10,000 ms	
Sweep Mode	SM	450–500 μ s	4.5 ms	
Data Transfer Mode	MD	450–500 μ s	4.5 ms	
Interrogate Function	IFU	675–750 μ s	1603 ms	
Interrogate Error	IER	675–750 μ s	11.5 ms	
Universal Commands		$\sim 225 \mu$ s per byte		
Amplitude Modulation	MA	450–500 μ s	7.0 ms	
Phase Modulation	MP	450–500 μ s	7.0 ms	

Table 1-5. Required Test Equipment.

Instrument	Critical Specifications	Required For				Recommended Model
		Oper. Ver.	Perf. Tests	Adjustments	Trouble-shooting	
Oscilloscope	Vertical Bandwidth: dc to 100 MHz Deflection: 0.01 V to 10V/div Horizontal Sweep: 0.05 μ s to 1 s/div x10 Magnification Delayed Sweep	X	X	X	X	-hp- 1740A
Electronic Counter	Frequency Measurement Frequency Range: to 20 MHz Resolution: 8 digits Accuracy: ± 2 counts Time Interval Average A to B Resolution: 0.1 ns	X	X	X		-hp- 5328A with Opt 01 and 040 or 041
Digital Voltmeter	DC Function Ranges: .1 V, 1 V, 10 V, 100 V Accuracy: $\pm .2\%$ Resolution: 4 $\frac{1}{2}$ digits AC Function Ranges: 1 V, 10 V, 100 V Accuracy: $\pm .5\%$ Resolution: 4 digits			X	X	-hp- 3466A
	DC Function Ranges: .1 V, 1 V, 10 V, 100 V Accuracy: $\pm .05\%$ Resolution: 6 digits AC Function: True RMS Ranges: 1 V, 10 V, 100 V Accuracy: $\pm .2\%$ Resolution: 6 digits Crest Factor: 4:1	X	X	X		-hp- 3455A
50-ohm Load	Accuracy: $\pm .2\%$ Power Rating: 1 W	X	X	X	X	-hp- 11048C
High Frequency Spectrum Analyzer	Frequency Range: 1 kHz to 100 MHz Amplitude Accuracy: $\pm .5$ dB	X	X	X		-hp-141T/8552B/8553B
Low Frequency Spectrum Analyzer	Frequency Range: 5 Hz-50 kHz Amplitude Accuracy: $\pm .5$ dB Spurious Responses: 80 dB below reference	X	X	X		-hp- 3580A
Sine Wave Signal Source	Frequency: 1 kHz Amplitude: 1 V rams into 20 k Ω Frequency Range:		X	X		-hp- 204C -hp- 3335A 1 MHz-20 MHz Amplitude Range: to + 7.0 dBm Output Impedance: 50 Ω Phase Noise (Integrated): 9.9 MHz: < - 63 dB 20 MHz: < - 70 dB Spurious: > 75 dB below fundamental
Double Balanced Mixer	Impedance: 50 Ω Frequency: to 20 MHz		X			-hp- 10534A or 10514A
1 MHz Low Pass Filter	Cut-off Frequency: 1 MHz Stopband Atten: 50 dB by 4 MHz Stopband Freq: 4 MHz-80 MHz		X			J903 TT Electronics, Inc. 2214 S. Barry Ave. Los Angeles, CA 90064
15 kHz Noise Equivalent Filter	Consisting of: Resistor: 10 k Ω $\pm 1\%$ Capacitor: 1600 pF $\pm 5\%$		X			-hp- 0757-0340 -hp- 0160-2223

Table 1-5. Required Test Equipment (Cont'd)

Instrument	Critical Specifications	Required For				Recommended Model
		Oper. Ver.	Perf. Tests	Adjustments	Trouble-shooting	
AC Voltmeter	Ranges: 0.1 V to 1 V Frequency Range: 20 Hz-1 MHz Input Impedance: $\geq 1 \text{ M}\Omega$ Meter: Log scale Acc (100 Hz to 10 kHz): $\pm 1\%$		X			-hp- 400 FL
Resistor	1 k Ω $\pm 5\%$			X		-hp- 0683-1025
Oscilloscope Probe	Division Ratio: 10 to 1 Impedance: 1 M Ω , 12 pF			X	X	-hp- 10041A
DC Power Supply	Volts: 0-10 V Amps: 10 mA Floating output		X	X		-hp- 6214A
Frequency Standard (Required for Option 001 Only)	Frequency: 5 MHz Accuracy: 1×10^{-9}			X		-hp- 105B
Calculator (Required for automatic testing)	HP-IB Control Capability	X	X			-hp- 9825A with 98034A Interface, General I/O ROM, Extended I/O ROM
System Voltmeter	DC Voltage: 0 to $\pm 10 \text{ V}$ Sample/Hold Measurement External Trigger: Low True TTL Edge Trigger Trigger Delay: selectable, 10 μs to 140 μs		X			-hp- 3437A
BNC Tee Adapter BNC-to-Triax Adapter	Male-female-female BNC-to-dual banana plug Female BNC-to-Male Triax	X X	X X X	X X		-hp- 1250-0781 -hp- 1250-2277 -hp- 1250-0595
Signature Analyzer	Signature: 4-digit hexadecimal Characters: 0 thru 9, A, C, F, H, P, U Threshold Logic 1: +2.2 V Logic 0: +0.5 V Clock Frequency: $\geq 1.5 \text{ MHz}$				X	-hp- 5004A
Pulse Generator	Pulse Rate: 500 kHz Pulse Width: $\leq 1 \mu\text{s}$ DC Offset: 1 V				X	-hp- 3312A
Resistor	665 Ω 1% 1/8 W	X	X			-hp- 0698-2511
Thermal Converter	Input Impedance: 75 Ω Input Voltage: 0.5 V rms Frequency: 2 kHz to 20 MHz Frequency Response: $\pm 0.05 \text{ dB}$ 2 kHz to 20 MHz		X			-hp- 11050A
Resistive Divider	Consisting of: Resistor: 36.5 Ω 1% 1/2 W Resistor: 13.7 Ω 1% 1/2 W		X			-hp- 0757-0996 -hp- 0698-4998
Resistive Divider	Consisting of: Resistor: 40.2 Ω 1% 1/2 W Resistor: 10 Ω 1% 1/2 W		X			-hp- 0698-5022 -hp- 0757-0984
Resistive Divider	Consisting of: Resistor: 30 Ω 1% 1/4 W Resistor: 20 Ω 1% 1/4 W		X			-hp- 0698-7533 -hp- 0698-6296
Resistive Divider	Consisting of: Resistor: 100 k Ω 1% 1/8 W Resistor: 162 k Ω 1% 1/8 W		X			-hp- 0757-0465 -hp- 0757-0470
Termination	50 ohm Feedthrough 1%		X			-hp- 11048C
Thermo Converter	BNC Connectors		X			-hp- 11050A

SECTION II INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains instructions for installing and interfacing the Model 3325A Synthesizer/Function Generator. Included are initial inspection procedures, power and grounding requirements, line voltage selection, environmental requirements, installation instructions, HP—IB connection procedure, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of marks and scratches and in perfect electrical order upon receipt. Procedures for checking electrical performance are given in Section IV. If there is mechanical damage or defect or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard Sales and Service Office listed at the rear of this manual. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping material for the carrier's inspection. The warranty statement is located in the front of this manual.

2-5. PREPARATION FOR USE.

2-6. Power Requirements.

2-7. The Model 3325A requires a power source of 100, 120, 220, or 240 V ac, +5%, -10%, 48 to 66 Hz single phase. Power consumption is 100 VA maximum.

2-8. Line Voltage Selection.



Before connecting ac power to this instrument, make sure it is set to the line voltage of the power source. Also ensure that the common connection of the power outlet is connected to a protective earth contact.

WARNING

The line voltage selection switches are located inside the top cover of the instrument. Line voltage selection should be done by trained service personnel only. To avoid electrical shock, make sure the power cord is disconnected before removing the instrument cover.

2-9. The line voltage selection switches are set at the factory to correspond to the line voltage option ordered. This information may be found on the rear panel.

Option	Line Voltage Selected
100	100 V
120	120 V
220	220 V
240	240 V

If it is necessary to change the line voltage selection, access to the switches may be gained by removing the top cover of the 3325A. Make the desired voltage selection as shown in Figure 2-1. Be sure to observe the CAUTION in Figure 2-1.

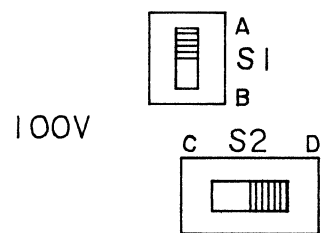
2-10. Power Cable.

2-11. In accordance with international safety standards, this instrument is equipped with a three-wire cable. When connected to an appropriate power line outlet, this cable grounds the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the connector configuration and -hp- part numbers of the available power cables.

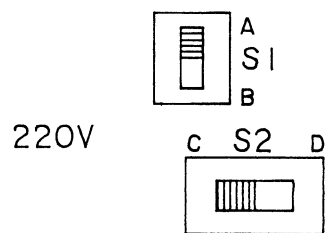
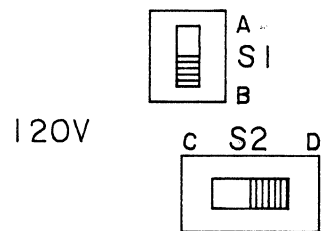
2-12. HP—IB Connections.

2-13. Interconnection data concerning the rear panel HP—IB connector is provided in Figure 2-3. This connector is compatible with the -hp- 10631 (A, B, or C) HP—IB cables. The lengths of these cables are as follows:

10631A	1 meter
10631B	2 meters
10631C	4 meters



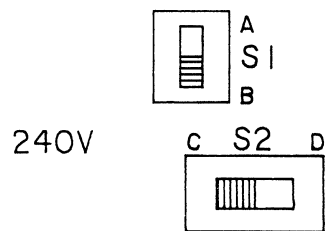
LINE VOLTAGE	S1	S2
100V	A	D
120V	B	D
220V	A	C
240V	B	C



CAUTION

WHEN CHANGING THE LINE VOLTAGE SELECTION, MAKE SURE THE CORRECT FUSE IS INSTALLED FOR THE VOLTAGE SELECTED.

LINE VOLTAGE	FUSE	-hp-PART NO.
100/120V	1A	2110-0001
220/24V	.5A	2110-0012



AFTER CHANGING LINE VOLTAGE SELECTION, BE SURE TO INDICATE ON THE REAR PANEL THE NEW VOLTAGE SELECTED.

3325A-29

SWITCHES VIEWED FROM
REAR OF INSTRUMENT

Figure 2-1. Line Voltage Selection.

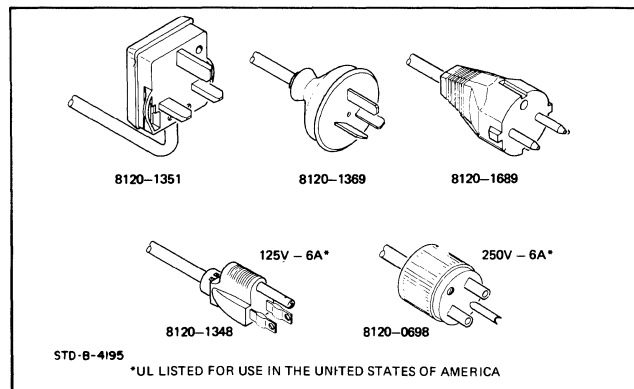


Figure 2-2. Power Cables.

Up to 15 instruments (including the controller) may be connected in an HP-IB system. The HP-IB cables have identical stacking connectors on both ends so that several cables can be connected to a single source. As a practical matter, avoid stacking more than three or four cables on any one connector. If the stack gets too large, the force on the stack can produce enough leverage to damage the connector mounting. Be sure that the connector screws are tightened firmly in place to keep it from working loose during use, and be sure to observe the

CAUTION of Figure 2-3.

2-14. Cable Length Restrictions. System components can be interconnected in virtually any configuration. However, to achieve reliable system performance, proper voltage levels and timing relationships must be maintained. If the system cable is too long, the lines cannot be driven properly and the system will fail to perform. The maximum length of cable that can be used to connect a group of instruments must not exceed 2 meters (6.5 ft.) times the number of instruments to be connected, or 20 meters (65.6 ft.), whichever is less.

2-15. 3325A Listen/Talk Address.

2-16. The 3325A is normally shipped from the factory with the listen address set to ASCII character 1; talk address Q. The 3325A address switches are located inside the top cover near the center of the instrument. The possible HP-IB addresses are shown in Table 2-1. Set the five switches (marked 1 through 5) to the correct positions corresponding to the ASCII code address chosen. The 3325A may be set to a "listen only" condition by setting the switch marked LON to the "1" position. Be sure to leave the ROM switch in the "1" position. This switch is used for troubleshooting only.

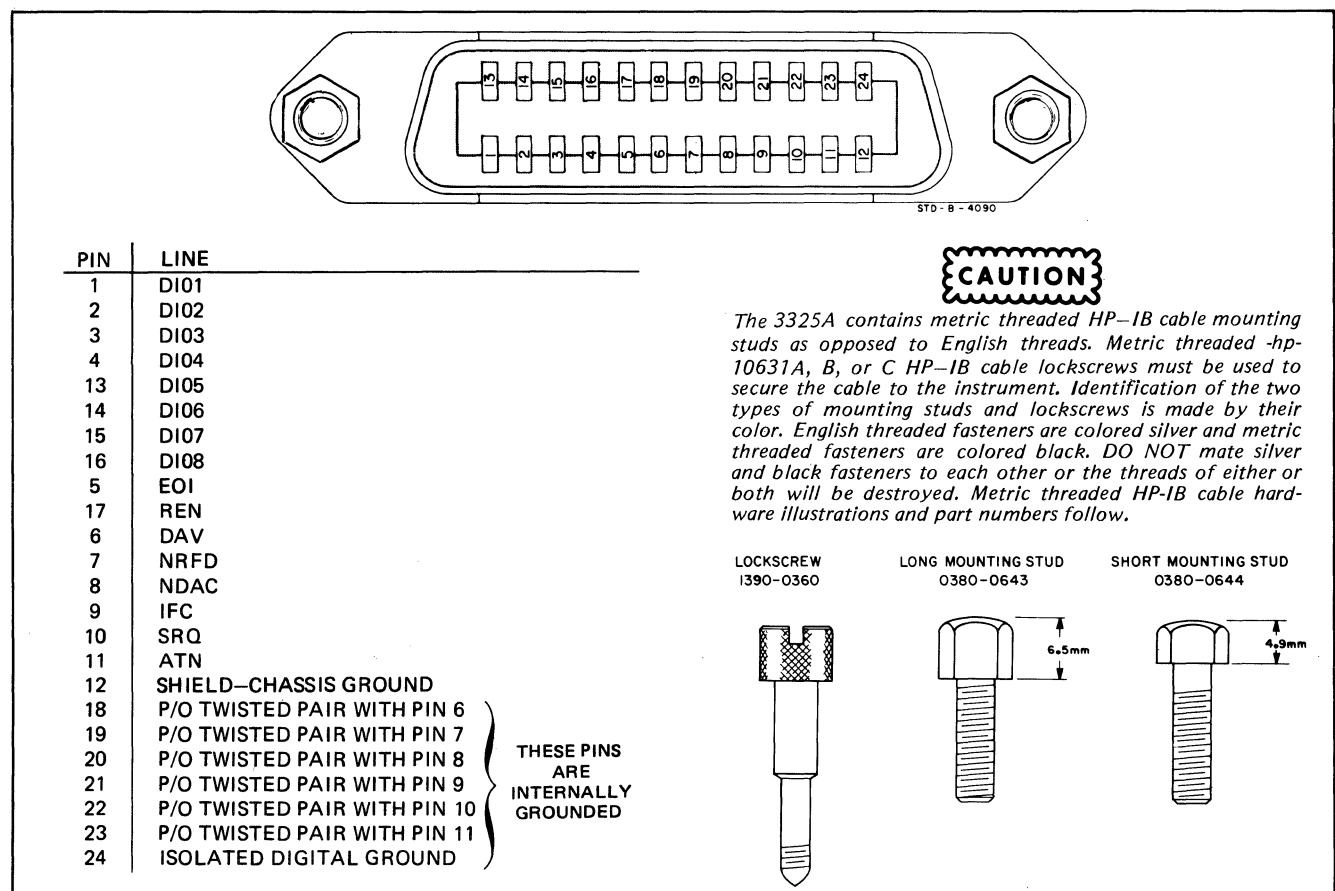


Figure 2-3. HP-IB Connector.

WARNING

Because the address switches are located inside the instrument, they should be set by trained service personnel only. To avoid electrical shock, make sure the power cord is disconnected before removing the instrument cover.

2-17. HP—IB Description.

2-18. A description of the HP—IB is provided in Section III of this manual. A study of this information is necessary if you are not familiar with the HP—IB concept. Additional information concerning the design criteria and operation of the bus is available in IEEE Standard 488-1975 "IEEE Standard Digital Interface for Programmable Instrumentation".

2-19. Connecting Oven Option 001.

2-20. In order to use the Oven Option 001, an external connection must be made between the rear panel 10 MHz OVEN OUTPUT and the REF IN connectors. A special connector for this purpose, -hp- Part No. 1250-1499, is supplied with instruments having Option 001.

2-21. OPERATING ENVIRONMENT.**WARNING**

To prevent potential electrical or fire hazard, do not expose equipment to rain or moisture.

2-22. In order for the 3325A to meet the specifications listed in Table 1-1, the operating environment must be within the following limits:

Temperature	0 to +55°C
Relative Humidity	95% at 40°C
Altitude	4600 meters (15,000 feet)

2-23. Cooling System.

2-24. The cooling fan intake and the exhaust vent are located in the rear panel. When operating the instrument, provide at least 75 mm (3 inches) of clearance at the rear, and at least 7 mm (¼ inch) on all sides of the instrument. Failure to allow adequate air circulation will result in excessive internal temperature, reducing instrument reliability.

2-25. It is imperative that the fan filter be inspected frequently and cleaned or replaced as necessary to permit the free flow of air through the instrument. To clean the

filter, remove the four nuts that secure the filter retainer. Remove the filter and flush with soapy water, rinse clean, and air dry.

2-26. Bench Operation.

2-27. The instrument has plastic feet attached to the bottom panel. The front feet contain foldaway tilt stands for convenience in bench operation. The tilt stand raises the front of the instrument for easier viewing of the control panel. The plastic feet are shaped to make full-width modular instruments self-align when they are stacked. A front handle kit, -hp- Part No. 5061-0089 (Option 907), can be installed for ease of handling the instrument on the bench (see Figure 2-4). The kit is shipped with the instrument if Option 907 is also ordered. Otherwise, the front handle kit is available separately by its -hp- part number.

2-28. Rack Mounting.

2-29. The 3325A can be rack mounted in a rack having an EIA standard width of 482.6 mm (19 inches). The instrument can be rack mounted with or without a handle kit by use of the following items:

- Rack mounting without handles; use Rack Mount Flange Kit -hp- Part No. 5061-0077 (Option 908).
- Rack mounting with handles; use the combination Rack Mount Flange/Front Handle Kit -hp- Part No. 5061-0083 (Option 909).

NOTE

The Rack Mount Flange Kit of item a will not provide the space requirement for rack mounting when used with the bench handle assembly (-hp- Part No. 5060-9899, Option 907). To rack mount with handles, the combination kit of item b (Option 909) must be used (see Figure 2-4). If either Option 908 or 909 is ordered, the corresponding kit is shipped with the instrument. Otherwise, both kits are available separately by their -hp- part numbers.

2-30. STORAGE AND SHIPMENT.**2-31. Environment.**

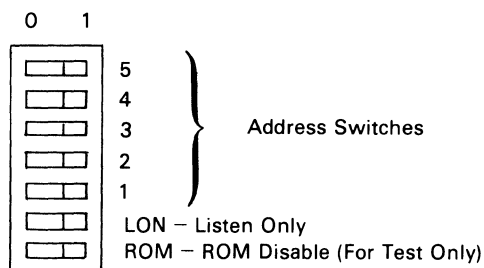
2-32. The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature	-40°C to +75°C
Relative Humidity	95% at 40°C
Altitude	15,300 meters (50,000 feet)

Table 2-1. HP—IB Addresses.

ASCII Characters		Address Switches (Binary Code)	Equivalent Codes (To 5-Bit Binary Switches)		
Listen Address	Talk Address		Octal	Decimal	Hexadecimal
SP	@	0 0 0 0 0	00	00	00
!	A	0 0 0 0 1	01	01	01
"	B	0 0 0 1 0	02	02	02
#	C	0 0 0 1 1	03	03	03
\$	D	0 0 1 0 0	04	04	04
%	E	0 0 1 0 1	05	05	05
&	F	0 0 1 1 0	06	06	06
'	G	0 0 1 1 1	07	07	07
(	H	0 1 0 0 0	10	08	08
)	I	0 1 0 0 1	11	09	09
*	J	0 1 0 1 0	12	10	0A
+	K	0 1 0 1 1	13	11	0B
,	L	0 1 1 0 0	14	12	0C
-	M	0 1 1 0 1	15	13	0D
.	N	0 1 1 1 0	16	14	0E
/	O	0 1 1 1 1	17	15	0F
0	P	1 0 0 0 0	20	16	10
1	Q	1 0 0 0 1	21	17	11
2	R	1 0 0 1 0	22	18	12
3	S	1 0 0 1 1	23	19	13
4	T	1 0 1 0 0	24	20	14
5	U	1 0 1 0 1	25	21	15
6	V	1 0 1 1 0	26	22	16
7	W	1 0 1 1 1	27	23	17
8	X	1 1 0 0 0	30	24	18
9	Y	1 1 0 0 1	31	25	19
:	Z	1 1 0 1 0	32	26	1A
;	[	1 1 0 1 1	33	27	1B
<	\	1 1 1 0 0	34	28	1C
=	]	1 1 1 0 1	35	29	1D
>	~	1 1 1 1 0	36	30	1E

Factory
Selected
Address →



NOTE: The Equivalent Codes shown correspond only to the 5-bit binary switch code. These bits are the same for both listen and talk addresses, and the sixth and seventh bits determine whether the address is listen (01) or talk (10). Some controllers distinguish between listen and talk automatically, requiring only the 5-bit code equivalent to designate a device.

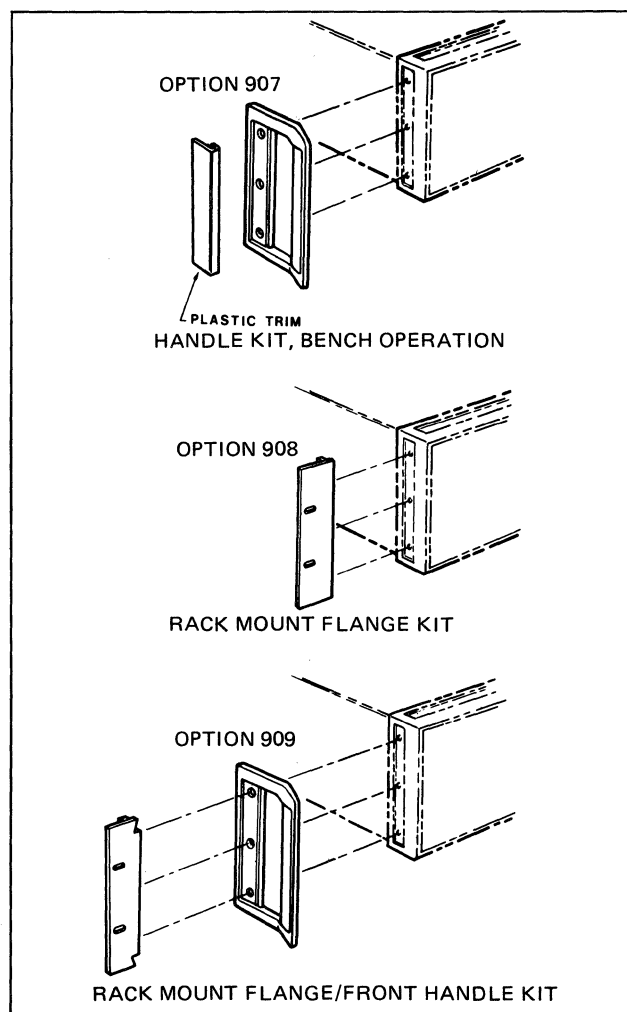


Figure 2-4. Rack Mount and Handle Kits.

2-33. Instrument Identification.

2-34. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. In any correspondence, refer to the instrument by model number and full serial number.

2-35. Packaging.

2-36. Original Packaging. If the original packaging has been retained, pack the instrument in the same manner as it was received. Be sure to seal the shipping container securely. Also, mark the container **FRAGILE** to assure careful handling.

2-37. Other Packaging. The following general instructions should be used for repackaging with commercially available materials.

a. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard office or service center, attach a tag indicating the type of service required, return address, model number, and full serial number.)

b. Use a strong shipping container. A doublewall carton made of 250-pound test material is adequate.

c. Use enough shock-absorbing material (3-to-4 inch layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark the shipping container **FRAGILE** to assure careful handling.

SECTION III OPERATION

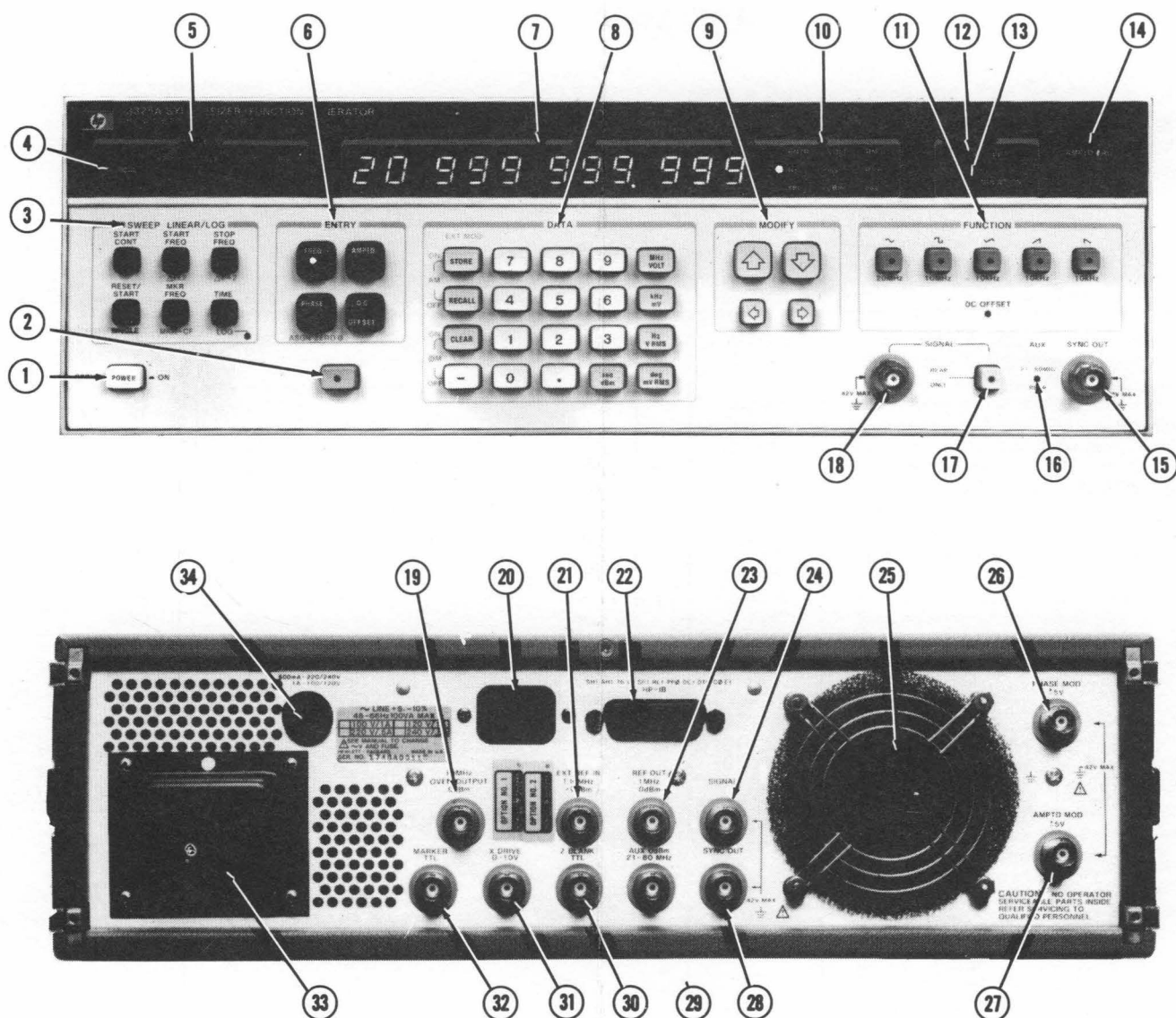
3-1. INTRODUCTION.

3-2. This section of the manual contains instructions for manual operation and HP-IB (Hewlett-Packard In-

terface Bus) programming. The HP-IB information includes the basic concepts of the interface bus operation, with which you may already be familiar. Use Table 3-1 to locate the information you need for your particular situation.

Table 3-1. Operating Information.

Paragraph	Content	Paragraph	Content
3-3	PANEL FEATURES (Figure 1-1)	3-100	3325A REMOTE PROGRAMMING
3-5	POWER/WARMUP	3-101	3325A HP-IB Capabilities
3-8	INITIAL CONDITIONS		Table 3-8, Interface Functions
3-10	SELF TEST	3-103	Developing an HP-IB Program
3-12	FRONT/REAR SIGNAL OUTPUT	3-107	Universal and Addressed Commands
3-14	SYNC OUTPUT	3-109	Placing the 3325A in Remote
3-16	EXTERNAL REFERENCE INPUT	3-111	The 3325A Address
3-18	10 MHz OVEN OPTION 001		Table 3-9, Summary of 3325A Programming,
3-20	MANUAL PROGRAMMING		ASCII Characters
3-22	Clear Display		Table 3-10, Programming Codes
3-24	Entry Errors	3-113	3325A Data Message Formats
3-26	Function Selection	3-115	Data Transfer Mode
3-28	Frequency Entry	3-118	Programming Data Transfer Mode
3-30	Frequency Limits	3-120	Programming Entry Parameters
3-32	Frequency Display and Resolution		Frequency
3-34	Auxiliary Output (Sine Function Only)		Amplitude
3-36	Amplitude Entry		Offset
	Table 3-2, Amplitude Limits of AC Functions		Phase
3-39	Amplitude Calibration		Sweep Start Frequency
3-41	High Voltage Output Option 002		Sweep Stop Frequency
	Table 3-3, High Voltage Output Amplitudes		Sweep Marker Frequency
3-43	DC Offset		Sweep Time
	Table 3-4 and Figure 3-2, Maximum DC	3-122	Programming Waveform Function
	Offset	3-124	Programming Binary (ON or OFF) Function
3-46	Phase Entry		High Voltage Output (Option 002)
3-49	Frequency Sweep		Amplitude Modulation
3-55	Sweep Marker		Phase Modulation
3-58	Sweep X Drive Output	3-126	Programming Selection Functions
3-60	Sweep Z Blank Output		Rear Output/Front Output
3-62	Amplitude Modulation		Linear Sweep/Logarithmic Sweep
3-66	Phase Modulation		Data Transfer Mode
3-68	Modify Keys	3-128	Programming Execution Functions
3-70	Store and Recall		Assign Zero Phase Reference
3-72	OPERATOR'S CHECKS		Perform Amplitude Calibration
3-74	Self Test		Start Single Sweep
3-76	Output Checks		Start Continuous Sweep
3-78	OPERATOR'S MAINTENANCE		Perform Self Test
3-81	HP-IB OPERATION	3-130	Programming Amplitude Units Conversion
3-83	General HP-IB Description	3-132	Programming Storage Registers
	Figure 3-3, Interface Connections and Bus	3-134	Service Requests
	Structure	3-136	Serial Poll
	Table 3-5, General Interface Management	3-138	Status Byte
	Lines	3-140	Busy Flag
3-88	Definition of HP-IB Terms and Concepts	3-142	Sweep Flag
3-89	Basic Device Communication Capability	3-144	Masking or Enabling Service Requests
3-91	Message Definitions		Table 3-11, SRQ Mask/Enable Data
	Table 3-6, Definition of Meta Messages	3-146	Interrogating Program Errors
3-93	3325A Response to Messages	3-148	Interrogating Entry Parameters
	Table 3-7, Implementation of Messages	3-150	Interrogating Function (Waveform)
3-95	HP-IB Work Sheet	3-152	Interrogating Miscellaneous Parameters
3-97	HP-IB Addressing	3-154	Using the Interrogate Capability
		3-156	3325A Programming Procedure
Appendices			
A-3			META MESSAGES BLOCK DIAGRAMMED
B-3			PROGRAMMING THE MODEL 3325A with the
			9825A CALCULATOR



- ① POWER STBY/ON Key. In the STBY position, power is applied to the Oven (Option 001), the HP-IB interface circuits that are external to the isolation barrier, and the High Voltage Output circuits (Option 002), in addition to the power supply circuits.
- ② BLUE prefix key. This key must be pressed to select any of the key functions labeled in blue.
- ③ SWEEP key group. These are entry prefix keys for the sweep parameters, plus the sweep start keys. When preceded by the blue prefix key, the sweep parameter keys control sweep modification functions and linear/log selection.

- ④ LOCAL key. Returns 3325A from remote to front panel control unless Local Lockout has been programmed. When preceded by the blue prefix key, this key causes the 3325A HP-IB address to be displayed in decimal code.
- ⑤ STATUS annunciator group. These annunciators indicate the 3325A HP-IB status: Remote; Addressed to Talk; Addressed to Listen; Request Service (SRQ).
- ⑥ ENTRY group. Prefix keys for programming signal parameters.
- ⑦ ALPHANUMERIC display. Displays the value of the parameter selected, error codes, failure modes, HP-IB address, amplitude and phase modulation state.

Figure 3-1. 3325A Front And Rear Panels.

- ⑧ DATA group. This group includes the numeric data keys, the data value suffix keys, the Store and Recall command keys, and the entry Clear key. When preceded by the blue prefix key, the keys in the left column control the modulation functions.
- ⑨ MODIFY group. The horizontal arrow keys select the digit to be modified (indicated by a bright digit), and the vertical arrow keys increment or decrement that digit.
- ⑩ UNITS annunciators. Display the units of volume represented by the numeric display. Entry annunciator indicates that an entry is in progress.
- ⑪ FUNCTION group. These keys select the output signal function or dc only (see Paragraph 3-26).
- ⑫ EXT REF annunciator is on if an external reference or the Option 001 internal 10 MHz oven reference is connected to the rear panel REF IN. Annunciator flashes if the 30 MHz internal reference is not phase locked to the external reference.
- ⑬ MODULATION annunciator is on if either AM or Phase modulation is programmed.
- ⑭ AMPTD CAL key. Automatically calibrates the amplitude and offset of the output signal (see Paragraph 3-39). When preceded by the blue prefix key, initiates a self test operation (see Paragraph 3-10).

CAUTION

The maximum peak voltage that can be safely applied between chassis and the outer conductor of any of the 3325A input or output signal connectors is ± 42 V.

- ⑮ SYNC OUT. A square wave sync signal is available at this connector and also at a rear panel connector, item 29. This signal is always in sync with the output signal crossover point. (Zero volts or dc offset voltage, see Paragraph 3-14.) J2.
- ⑯ AUX 21-60 MHz REAR annunciator. This annunciator is on when the rear panel AUX output is active (see Paragraph 3-34).
- ⑰ REAR ONLY key. In standard instruments, switches signal output from front to rear panel and vice versa. Rear panel output is active when the annunciator in the center of the key is on. In instruments with High Voltage Output Option 002, this key switches from normal to high voltage output, and the annunciator indicates when the high voltage output is on. The key is labeled "40 Vpp, 40 mA, 0-1 MHz" for Option 002. In Option 002 instruments, no rear panel signal output is provided.
- ⑱ SIGNAL output. Standard output impedance is 50 ohms. High Voltage Output Option 002 output impedance is nominally < 2 ohm at dc and < 10 ohms at 1 MHz. Load impedance must be at least 500 ohms. Standard and High Voltage amplifier outputs are fused. J1.
- ⑲ 10 MHz OVEN OUTPUT. This signal is present only in instruments with Option 001. To make use of the Oven Output, it must be connected to the REF IN connector, Item 21. A special connector, -hp- Part No. 1250-1499, is supplied with Option 001 for this purpose. J3.

- ⑳ AC POWER input connector. E1.
- ㉑ REF IN. An external reference may be used to phase lock the internal 30 MHz reference (see Paragraph 3-16). J4.
- ㉒ HP-IB connector. Remote control of the 3325A by means of an HP-IB system controller is accomplished through this connector. Part of W6.
- ㉓ REF OUT. A 1 MHz signal from the 3325A reference circuits is available at this connector. J5.
- ㉔ SIGNAL. The output signal is switched to this connector by the front panel REAR ONLY key, Item 17. J6. (Instruments with Option 002 do not have rear panel signal output.)

NOTE

The rear panel signal output is inactive (no internal signal connection) if the instrument has the High Voltage Output Option 002 installed. Instructions are given in the Operating and Service Manual, Section VIII, Service Group M, for activating the rear panel signal output in one of two ways: 1) Placing the standard/high voltage output on the rear panel only, disconnecting the front panel signal output, or 2) Disabling the high voltage output and enabling the standard front/rear output configuration.

If the standard instrument signal output is not terminated by an external 50-ohm load (a high impedance load, for example) undesirable distortion may result, particularly at higher frequencies. Similar conditions may result if the High Voltage Output (Option 002) is terminated by less than 500 ohms.

- ㉕ BLOWER, B1.
- ㉖ PHASE MOD. Input connector for a phase modulating signal of ± 5 V maximum peak voltage (see Paragraph 3-66). J7.
- ㉗ AMPTD MOD. Input connector for an amplitude modulating signal of ± 5 V maximum peak voltage (see Paragraph 3-62). J8.
- ㉘ AUX 21-60 MHz. A signal is available at this output when the sine wave frequency is programmed above 21 MHz (see Paragraph 3-34). J9.
- ㉙ SYNC OUT. This output is identical to the output at the front panel sync connector, Item 15. J10.
- ㉚ Z BLANK. A TTL compatible output is present during a sweep operation (see Paragraph 3-60). J11.
- ㉛ X DRIVE. This output progresses from 0 V to +10 V during a sweep-up operation (see Paragraph 3-58). J12.
- ㉜ MARKER. This TTL compatible output goes low at the selected marker frequency during a sweep up, and high at completion of the sweep (see Paragraph 3-55). J13.
- ㉝ Power Transformer, T1.
- ㉞ Line Fuse, F1.

NOTE

The HP-IB is Hewlett-Packard Company's implementation of IEEE Standard 488-1975.

3-3. PANEL FEATURES.

3-4. Figure 3-1 identifies and describes the functions of the front and rear panel controls, indicators, and connectors.

3-5. POWER/WARM-UP.

3-6. The Model 3325A requires a power source of 100, 120, 220, or 240 Vac, +5% -10%, 48 to 66 Hz single phase. The selection of line voltage and fuse is described in Paragraph 2-8 and Figure 2-1.

3-7. The 3325A POWER switch has two positions, STBY and ON. Power is applied to some circuits at any time the instrument is connected to the ac power source. If the instrument has the Oven Assembly Option 001 installed, it is important that it remain connected to the power source to maintain a constant oven temperature, eliminating the need for a long warm-up period. If an instrument with the Oven Assembly has been disconnected from ac power no longer than 24 hours, a 15-minute warmup period is sufficient to bring the reference frequency to within $\pm 1 \times 10^{-7}$ of final value.

3-8. INITIAL CONDITIONS.

3-9. After the POWER switch has been set to ON, the instrument status will be as follows:

Function	Sine
Frequency	1000 Hz
Amplitude	1 mV p-p
Phase	0 deg
DC Offset	0 V
Front Signal Output	
Sweep	Linear
Start Frequency	1 MHz
Stop Frequency	10 MHz
Marker Frequency	5 MHz
Time	1 sec

NOTES

1. If the display reads OSC FAIL the frequency synthesis circuits are not operating properly.

2. If A-CAL FAIL appears in the display momentarily after turn-on, any one of the three AMPTD CAL tests could be incorrect. Perform a SELF TEST operation to identify the failure.

3. If either of the above conditions occurs, refer the instrument to qualified service personnel for repair.

3-10. SELF TEST.

3-11. The self test operation is initiated by pressing the blue prefix key, then the SELF TEST key (AMPTD CAL). This test uses the control, ROM, and control clock circuits to perform the following checks:

LED check: Turns on all LED's for about 2 seconds

Check 1: Tests AMPTD CAL of the sine wave

Check 2: Tests AMPTD CAL of the square wave

Check 3: Tests AMPTD CAL of the triangle wave

Following each check the display indicates either PASS or FAIL for approximately one second. If all tests pass, this indicates that approximately 60% of all circuits are operating properly.

3-12. FRONT/REAR SIGNAL OUTPUT.

The maximum peak voltage that can be safely applied between chassis and the outer conductor of any of the 3325A input or output signal connectors is ± 42 V.

3-13. The standard Model 3325A provides selectable front or rear panel 50-ohm signal outputs. The rear panel signal output is selected by pressing the REAR ONLY key. The lighted indicator in the center of this key denotes that the signal output is at the rear panel.

NOTE

The rear panel SIGNAL output is not present on instruments equipped with the High Voltage Output Option 002.

3-14. SYNC OUTPUT.

3-15. A square wave sync output is provided at BNC connectors on both the front and rear panels. This sync signal is always in phase with the output signal, with the sync transition occurring at the signal zero crossing, or when the signal crosses the dc offset voltage. The output impedance of either front or rear panel sync output is approximately 50 ohms. When connected to a 50-ohm coaxial cable that is terminated by a 50 ohm resistive load, the sync signal levels are as follows:

Low Level = < 0.2 V

High level = > 1.2 V

NOTE

If a sync output is connected to a 50-ohm coaxial cable that is terminated by a high impedance load (≥ 1 megohm) the voltage levels are approximately twice the values given above. However, the improper ter-

mination of the 50-ohm system will cause ringing at the positive and negative transitions of the sync signal.

3-16. EXTERNAL REFERENCE INPUT.

3-17. The 3325A may be operated with an external reference to control the standard 30 MHz internal reference oscillator frequency. The external reference level must be greater than 0 dBm (50 ohms), and the frequency must be within 10 PPM of 10 MHz or a sub-multiple thereof down to 1 MHz (10, 5, 3.33, 2.5, or 1 MHz). The front panel EXT REF annunciator will light to indicate that an external reference is being used. The internal reference oscillator is phase locked to the external reference, and a phase lock detector circuit causes the EXT REF light to flash if synchronization is lost.

3-18. 10 MHz OVEN OPTION 001.

3-19. Option 001 is a temperature stabilized 10 MHz oscillator which provides improved frequency stability (see specifications in Table 1-1). The output from this oscillator is at the rear panel 10 MHz OVEN OUTPUT connector. This output must be connected to the EXT REF input. A special connector, -hp- Part No. 1250-1499, is provided with Option 001 for this purpose.

3-20. MANUAL PROGRAMMING.

3-21. The following paragraphs describe the procedures for operating the 3325A from the front panel. Also included are the limits for each parameter.

3-22. Clear Display.

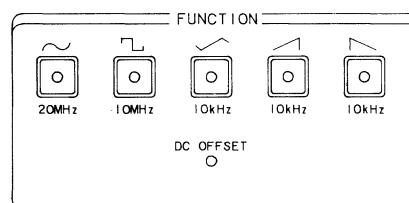
3-23. Pressing the CLEAR key (in the left column of the DATA group) clears the display to zero. This key is useful when an error is made while entering data.

3-24. Entry Errors.

3-25. The word "Error" will appear in the display for approximately one second when an error in programming occurs. The incorrect entry will not be accepted.

ASCII Numeric	Error
1	Entry parameter out of bounds (for example, Freq $\geq$ 61 MHz)
2	Invalid delimiter
3	Frequency too large for function (for example, Function = Triangle, Freq $\geq$ 11 kHz)
4	Sweep time too small or too large
5	Offset incompatible with amplitude, or amplitude incompatible with offset
6	Sweep frequency too large for function; Sweep bandwidth too small; Start frequency too small (log sweep); Start frequency greater than stop frequency (log sweep)
7	Unrecognizable mnemonic received
8	Unrecognizable data character received
9	Option does not exist (High Voltage or Rear/Front)

3-26. Function Selection.

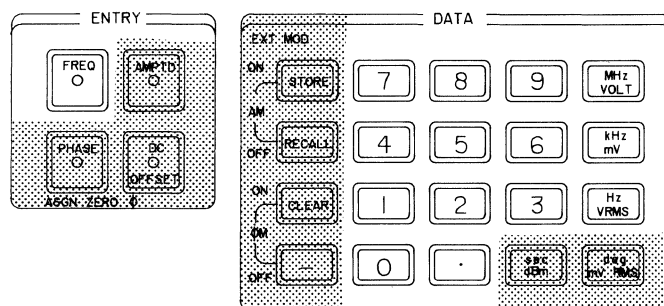


3-27. Any of the five functions may be selected by pressing the appropriate FUNCTION key. A light in the center of the key indicates the present function. Pressing the same key the second time removes the ac signal, setting the output to zero unless a dc offset has been programmed (see Paragraph 3-43). When the ac signal is removed in this way, the instrument automatically displays dc offset, and the dc offset entry key light comes on. The ac signal can be restored by pressing the FUNCTION key again. The output signal for each function is centered about zero volts unless a dc offset has been programmed.

NOTE

The standard instrument signal output must be terminated by an external 50-ohm load or sine wave distortion and square wave overshoot may result, particularly at higher frequencies.

3-28. Frequency Entry.



NOTE

A lighted indicator in the center of any entry key denotes it as the active entry parameter. For example, if the FREQ entry key indicator is on, it is not necessary to press that key before entering data.

3-29. Enter frequency by first pressing the FREQ ENTRY key, then the numerical data, followed by the data suffix (delimiter) key (Hz, kHz, MHz). Numerical data must be entered most significant digit first, entering the decimal in the proper place. The frequency parameter is stored in the 3325A when the delimiter key is pressed.

3-30. Frequency Limits.

3-31. The minimum frequency for all functions is 1 μ Hz. The nominal maximum frequency for each function is shown below the function select key on the front

Table 3-2. Amplitude Limits of AC Functions.

Function	Peak-to-Peak		rms		dBm (50 Ω)	
	Max.	Min.	Max.	Min.	Max.	Min.
Sine	10 V	1 mV	3.536 V	0.354 mV	+23.98	-56.02
Square	10 V	1 mV	5.000 V	0.5 mV	+26.99	-53.01
Triangle	10 V	1 mV	2.888 V	0.289 mV	+22.22	-57.78
$\pm$ Ramp	10 V	1 mV	2.888 V	0.289 mV	+22.22	-57.78

panel. However, because of the overrange capability of the 3325A, the maximum frequency for each function is as shown below:

Sine wave	20 999 999.999 Hz
Square wave	10 999 999.999 Hz
Triangle	10 999.999 999 Hz
Positive slope ramp	10 999.999 999 Hz
Negative slope ramp	10 999.999 999 Hz

3-32. Frequency Display and Resolution.

3-33. Frequency is always displayed in Hz, even though the entry may have been made in kHz or MHz. For example, an entry of 1.2 MHz is displayed as 1 200 000.0 Hz. Non-significant zeroes to the right of the first digit following the decimal point are not displayed except during a “modify” condition (see Paragraph 3-68). The maximum resolution is 1 μ Hz for frequencies up to and including 99 999.999 999 Hz, and 1 mHz for frequencies of 100 000.000 Hz and higher.

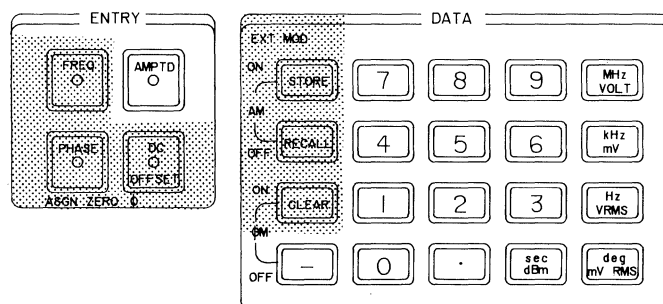
3-34. Auxiliary Output (Sine Function Only).

3-35. A rear panel auxiliary output can be used for frequencies above 19 MHz to a maximum of 60 999 999.999 Hz. The output level is a nominal 0 dBm into 50 ohms. The output automatically switches to the AUX output when frequencies of 21 000 000.000 Hz or higher are programmed. For this reason, the AUX output is labeled “21–60 MHz”. Frequencies between 19 MHz and 21 MHz can be obtained at the AUX output only by first entering 21 MHz or higher, then entering the desired frequency. For example, if the desired frequency is 19.5 MHz, first enter “FREQ 21 MHz”, then “19.5 MHz”. Then, if a front panel SIGNAL output of 19.5 MHz (or any frequency between 19 MHz and 21 MHz) is desired, enter any frequency 19 MHz or lower, then enter 19.5 MHz.

NOTE

Only one signal output is active at one time. A lighted “21-60 MHz Rear” annunciator indicates that the rear panel AUX, 0 dBm, 21-60 MHz output is active. A lighted “Signal, Rear Only” annunciator indicates that the rear panel signal output is active. Neither light on, indicates the front panel signal output is active.

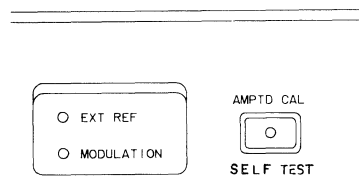
3-36. Amplitude Entry.



3-37. Amplitude is entered and displayed with 4-digit resolution. Press the AMPTD ENTRY key, then the numerical data, followed by the V, mV, Vrms, mVrms, or dBm key. The V and mV keys enter peak-to-peak value of ac functions. Maximum and minimum amplitudes for each function are shown in Table 3-2.

3-38. The 3325A will convert an amplitude value between peak-to-peak, rms, or dBm for any function. For example, if a sine wave amplitude of 10 V p-p has been entered, press the Vrms or mVrms key to display the same amplitude as 3.536 Vrms, or press the dBm key to display the value as (+)23.98 dBm.

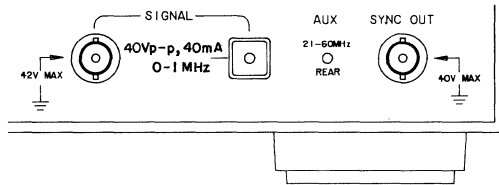
3-39. Amplitude Calibration.



3-40. The 3325A will calibrate the output signal when the AMPTD CAL key is pressed. The output goes to less than 4 mV p-p while the calibration is in process. An amplitude and offset calibration is performed automatically whenever the function is switched and at instrument turn-on.

NOTE

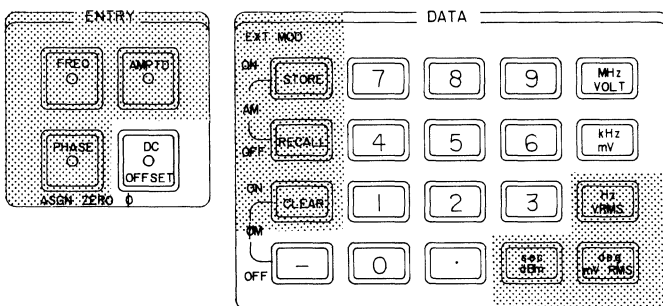
If A-CAL FAIL appears in the display momentarily after an AMPTD CAL operation, the instrument should be referred to qualified service personnel for repair.

3-41. High Voltage Output Option 002.

3-42. The high voltage output is selected by pressing the key in the lower right corner of the front panel. This option provides a maximum output of 40 V p-p into a high impedance. The load resistance must be greater than 500 ohms or distortion will result, particularly at higher frequencies. To assure square wave overshoot <5% of peak-to-peak output, the total capacitance connected to the output should be <500 pF. The same entry procedures and display features apply as in the standard operation. Maximum and minimum amplitudes are shown in Table 3-3. Maximum frequency for sine and square wave functions is 1 MHz (10 kHz for triangle and ramps).

NOTE

The rear panel signal output is inactive (no internal signal connection) if the instrument has the High Voltage Output Option 002 installed. Instructions are given in the Operating and Service Manual, Section VIII, Service Group M, for activating the rear panel signal output in one of two ways: 1) Placing the standard/high voltage output on the rear panel only, disconnecting the front panel signal output, or 2) Disabling the high voltage output and enabling the standard front/rear output configuration.

3-43. DC Offset.**Table 3-3. High Voltage Output Amplitudes (Option 002).**

Function	Peak-to-Peak		rms	
	Max.	Min.	Max.	Min.
Sine	40 V	4 mV	14.14 V	1.42 mV
Square	40 V	4 mV	20.0 V	2.0 mV
Triangle	40 V	4 mV	11.55 V	1.16 mV
± Ramp	40 V	4 mV	11.55 V	1.16 mV

3-44. Offset Only, No AC Function. When no ac function is present, the dc voltage output may be programmed from 0 mV to + or -5 V, with 4 digit resolution. When no ac function is present, the DC OFFSET entry prefix is automatically selected. It is necessary merely to enter the numerical data followed by the V or MV delimiter. The rms keys cannot be used to enter offset.

NOTE

When the High Voltage Output is selected (Option 002), minimum amplitude for dc only (no ac function) is 0.01 mV and maximum is 20.0 V.

3-45. Offset with AC Function. When dc offset is to be added to any ac function, there are minimum and maximum offset limits which must be observed. These limits are affected by the ac voltage and the resulting attenuator settings, which are shown in Table 3-4. Figure 3-2 is a set of graphs which show the approximate maximum dc offset permissible for a given ac peak-to-peak voltage. The following equation may be used to determine maximum offset voltage.

$$\text{Maximum dc offset} = \frac{5}{A} - \frac{\text{Amptd}}{2}$$

Where A = Attenuator factor (from Table 3-4)
Amptd = Amplitude in V p-p of the ac function

NOTES

1. If an attempt is made to enter a dc offset that is too great for the amplitude already programmed, "Error 5" will appear in the display momentarily, and the dc offset entry will not be accepted.

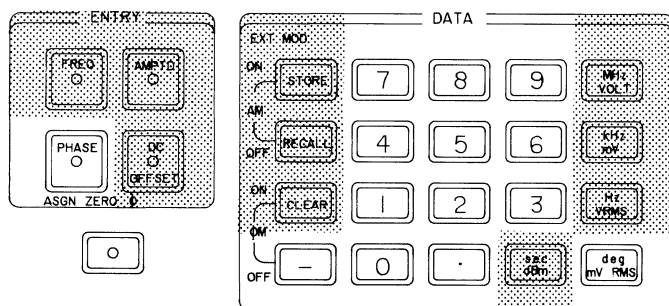
2. After a dc offset has been entered, if the amplitude (ac) is then increased beyond the level where the amplitude and offset are compatible, "Error 5" will appear in the display momentarily, and the ac amplitude entry will not be accepted.

3. The minimum and maximum permissible dc offset voltages when the High Voltage Output is selected (Option 002) may be determined by multiplying the amplitude and offset values in Table 3-4 by four. This also applies for Figure 3-2. Change the above equation (for determining maximum dc offset) to the following:

$$\text{Maximum dc offset} = \frac{20}{A} - \frac{\text{Amptd}}{2}$$

4. Resolution of a dc offset entry (with ac function) is determined by the resolution of the ac amplitude.

3-46. Phase Entry.

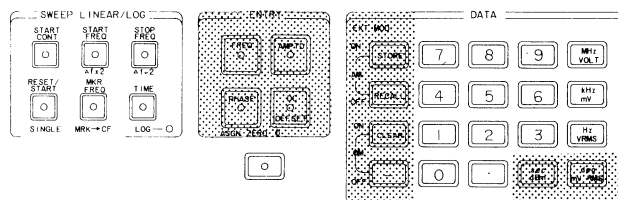


3-47. The phase of the SIGNAL output can be shifted up to $\pm 719.9^\circ$ with respect to the 1 MHz REF OUT (rear panel). Phase shift entry resolution is 0.1° . To program phase shift, press the PHASE ENTRY key, enter

number of degrees of phase desired, then press the “deg” key. For a negative phase shift, press the “-” key before entering the numerical data. For square wave frequencies below 25 kHz, phase changes greater than 25° may result in a phase shift $\pm 180^\circ$ from the desired amount.

3-48. After entering a phase shift, the new phase may be assigned the zero phase position, and subsequent changes in phase referenced to that point. To assign zero phase, press the blue entry prefix key, then press ASGN ZERO 0 (PHASE) key.

3-49. Frequency Sweep.

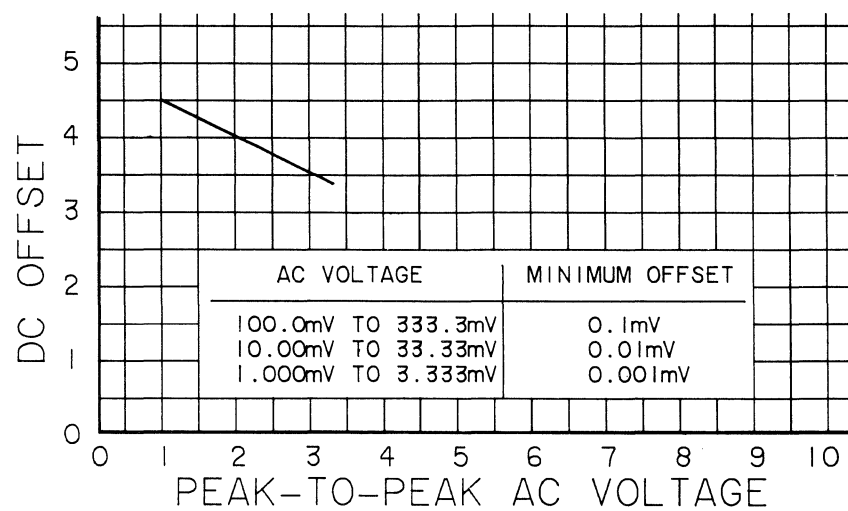
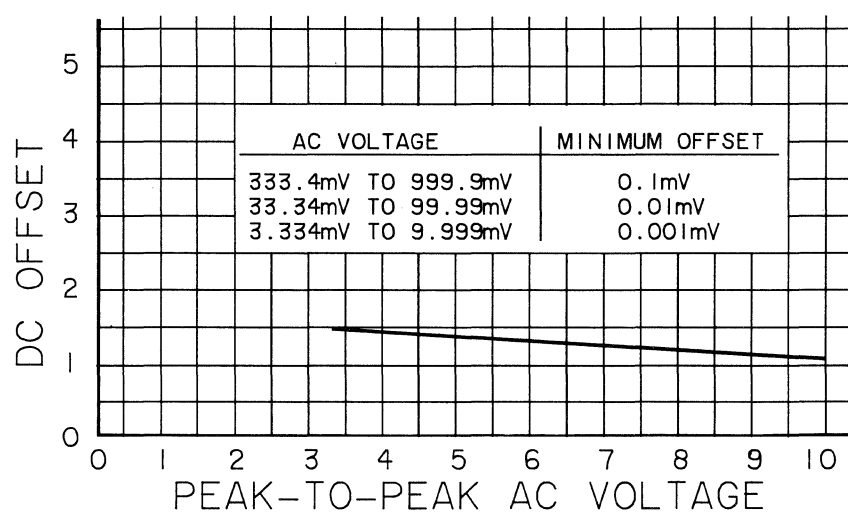
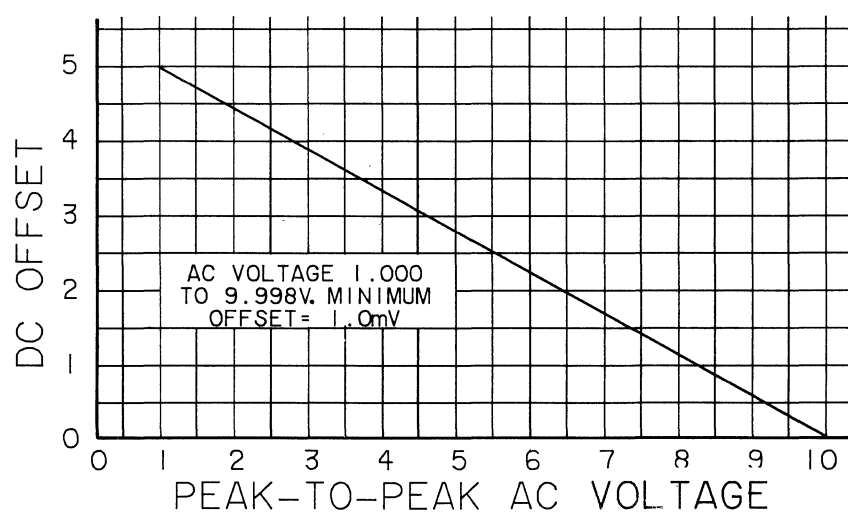


3-50. Frequency sweep is phase continuous over the full frequency range; that is, there are no discontinuities in the output waveform. When the instrument is turned on, the sweep mode is set to linear, and the parameters are set as follows:

Start Frequency.....1 000 000.0 Hz
 Stop Frequency.....10 000 000.0 Hz
 Marker Frequency.....5 000 000.0 Hz
 Time.....1.0 sec

Table 3-4. Maximum DC Offset with any AC Function.

AC Amplitude Entry (peak-to-peak)	Maximum DC Offset (+ or -)	Minimum DC Offset Entry	Range	Attenuation Factor
1.000 mV to 3.333 mV	with 4.500 mV to 3.333 mV	0.001 mV	7	A = 1000
3.334 mV to 9.999 mV	with 14.99 mV to 11.66 mV	0.001 mV	6	A = 300
10.00 mV to 33.33 mV	with 45.00 mV to 33.33 mV	0.010 mV	5	A = 100
33.34 mV to 99.99 mV	with 149.9 mV to 116.6 mV	0.010 mV	4	A = 30
100.0 mV to 333.3 mV	with 450.0 mV to 333.3 mV	0.100 mV	3	A = 10
333.4 mV to 999.9 mV	with 1.499 V to 1.166 V	0.100 mV	2	A = 3
1.000 V to 9.998 V	with 4.500 V to 0.001 V	1.000 mV	1	A = 1



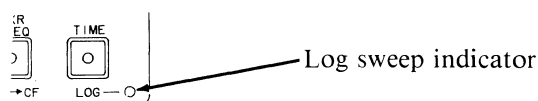
3325A-30

Figure 3-2. Maximum DC Offset With AC Functions.

NOTE

The Marker Frequency must be lower than Stop Frequency by a sufficient amount to permit the Marker pulse width to be approximately 400 microseconds. See Paragraph 3-55.

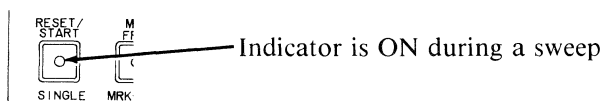
To change any of the sweep parameters, press the appropriate SWEEP entry key, then enter the desired data. To select LOG sweep, press the blue prefix key and then the LOG (TIME) key. The log indicator should light. The sweep mode is linear unless this light is on.



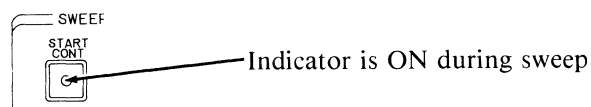
3-51. Linear Sweep. In linear mode, either CONTINUOUS or SINGLE sweep may be used. Single sweep is from START to STOP frequency, and either START or STOP may be the higher frequency. To begin a single sweep:

Press "RESET/START" key to set output and display to the start frequency selected and reset the X Drive ramp.

Press "RESET/START" key again to start the sweep.



The output frequency sweeps to the STOP frequency selected and remains there. This frequency appears in the display. Continuous sweep is up-down-up, etc., and begins when the "START CONT" key is pressed. Continuous sweep may be stopped by pressing the "START CONT" key again, or by pressing "START SINGLE", "FREQ ENTRY", or "PHASE ENTRY". The display will indicate the frequency at which the sweep stopped. The sweep will stop while any other parameter is being changed, then will restart. Pressing "AMPTD CAL", "SELF TEST", "ASSIGN ZERO 0", or changing the function will also stop continuous sweep.



3-52. Log Sweep. In either single or continuous log sweep mode, the stop frequency must be higher than the start frequency, and sweep is up only. (Continuous sweep is start to stop, start to stop, etc.) The minimum bandwidth for log sweep is one decade. Single log sweep is a line-segmented log approximation in one-tenth

decade segments, and continuous log sweep is a two-segment log approximation.

NOTE

Because of the computation time required by the control circuits in log sweep, the actual stop frequency (which is displayed at the end of a single sweep) will be higher than the selected stop frequency, but always within 0.25%. The error decreases as sweep time is increased.

3-53. Sweep Time. The maximum time per sweep (up or down) for all sweep modes is 99.99 seconds, with .01 second resolution for times ≥ 1 second, and .001 second resolution for times < 1 second. Minimum times are as follows:

Linear sweep, single or continuous...	0.010 s
Log sweep	
Single.....	2.000 s
Continuous.....	0.100 s

NOTE

In single log sweep, the sweep time is increased by the processing time required between segments. The time increase (in seconds) is approximately equal to

$$.045 \left(10 \log \frac{\text{stop frequency}}{\text{start frequency}} \right)$$

3-54. Sweep Bandwidth. The maximum sweep bandwidth is the full frequency range for the function selected, except that in log sweep, the minimum frequency is 1 Hz. The minimum bandwidth for log sweep is one decade. Minimum bandwidth for each function (linear sweep) is as follows:

Sine.....	(10 mHz/s) $\times$ (sweep time)
Square.....	(5 mHz/s) $\times$ (sweep time)
Triangle.....	(0.5 mHz/s) $\times$ (sweep time)
Ramps.....	(1 mHz/s) $\times$ (sweep time)

For sweep bandwidths of less than 100 times the minimum, Bandwidth selected should be an integral multiple of the minimum. In linear sweep mode the sweep bandwidth may be multiplied or divided by two by pressing the blue prefix key and then " $\Delta f \times 2$ " or " $\Delta f \div 2$ ". These bandwidth modification keys do not operate in log sweep mode.

3-55. Sweep Marker.

3-56. The marker frequency may be set to any point within the sweep band up to within approximately 400 microseconds of the stop frequency. If the marker frequency is set beyond this point, the stop frequency will automatically be increased so that the marker pulse is

approximately 400 microseconds wide. The following equation may be used to determine the approximate maximum marker frequency:

$$\text{Max. marker freq.} = \text{stop freq.} - \frac{.0004 \times \text{bandwidth}}{\text{sweep time}}$$

The rear panel MARKER output is at TTL compatible voltage levels. It is High at the start of a sweep up, goes Low at the selected marker frequency, then High again at the stop frequency. No marker output is present during sweep down or during a log sweep. Set the marker frequency by pressing the "MKR FREQ" key and entering the numerical data and the frequency suffix.

3-57. The sweep band can be moved up or down to center on the marker frequency by pressing the blue prefix key and then the MKR — CF(MKR FREQ) key. This does not change the sweep bandwidth unless either the new upper or lower limit would be beyond the frequency limit for the present function.

3-58. Sweep X Drive Output.

3-59. The rear panel X DRIVE output is as follows:

Linear sweep:

Single: 0 V at start, increasing linearly to $> +10$ V at stop, whether the sweep is up or down. Remains at essentially this voltage until reset prior to the start of another sweep. (Voltage will drift downward less than 10 mV/s.)

Continuous: Increases linearly from 0 V to $> +10$ V during sweep up, then goes to 0 V at beginning of sweep down and remains at 0 V during sweep down.

Log sweep: Starts at 0 V and increases to $> +10$ V with the sweep segments.

NOTE

The X DRIVE output has a nominal voltage of +10.5 V at the end of a sweep. This final voltage is specified to be greater than 10.0 V to ensure compatibility with oscilloscopes having a horizontal sensitivity of 10.0 V for full-screen deflection.

X DRIVE output voltage is linear with time in both linear and log sweep modes.

3-60. Sweep Z Blank Output.

3-61. The Z BLANK output voltages are TTL compatible, and the output logic levels are as follows:

Linear sweep:

Single: Goes LOW at start of sweep, HIGH at stop, whether the sweep is up or down. Remains until start of next sweep.

Continuous: LOW during sweep up, HIGH during sweep down.

Log sweep: Goes LOW at start frequency, HIGH at stop. In single sweep, remains HIGH until start of next sweep. In continuous sweep, is HIGH momentarily at stop frequency.

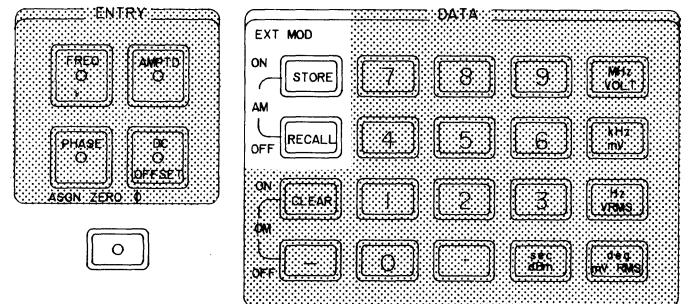
When the Z BLANK output is low, it is capable of sinking current through a relay or other device. The maximum ratings are:

Maximum current sink: 200 mA

Allowable voltage range: 0 V to +45 V dc

Maximum power (voltage at output x current): 1 W

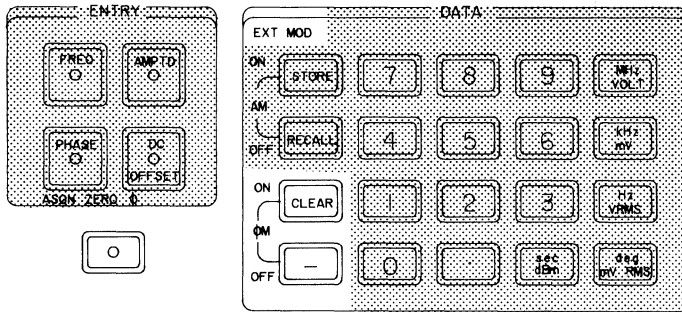
3-62. Amplitude Modulation.



3-63. To program amplitude modulation, press the blue prefix key, then press the "AM ON" (STORE) key. To remove the modulation, press the blue key, then "AM OFF" (RECALL). The display shows "A ON" or "A OFF" momentarily to indicate the status of the amplitude modulation. The status of phase modulation (P ON or P OFF) is displayed at the same time. The modulation input must be connected to the rear panel AMPTD MOD input. The impedance of this input is 20 kΩ (10 kΩ when AM is OFF).

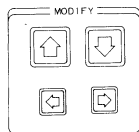
3-64. When amplitude modulation is programmed, the amplitude of the output signal (with no modulation) is halved; however, the display still indicates the programmed amplitude. Then, when the output (carrier) is modulated 100%, the maximum amplitude of the modulated output equals the programmed amplitude. A modulation input of approximately 5 V peak results in 100% modulation. Modulation frequency may be 0 to 50 kHz. If amplitude modulation is ON when 3325A functions other than sine wave are selected, the output may be gated, depending on the level of the modulation input. Amplitude modulation should be used only with the sine wave function, and the modulation input should not exceed ± 10 V peak.

3-65. A dc voltage may be applied to the AMPTD MOD input to control the 3325A output level, or a pulse may be used to gate the output. Approximately +5 V cuts off the output signal, while approximately -5 V doubles the output. (Maximum output is 10 V p-p.) DC or pulse inputs should not exceed ± 5 V peak.

3-66. Phase Modulation.

3-67. To program phase modulation, press the blue prefix key, the the "ØM ON" (CLEAR) key, and to remove phase modulation, press the blue key, then "ØM OFF" (-). The phase modulation signal at the rear panel PHASE MOD input may be up to ± 10 V peak. The input impedance is 10 k Ω . The modulating signal frequency may be dc to 5 kHz. An input of ± 5 V results in the following approximate phase deviation ($\pm 170^\circ$ per volt for sine function):

3325A Function	Phase Deviation
Sine	$\pm 850^\circ$
Square	$\pm 425^\circ$
Triangle	$\pm 42.5^\circ$
$\pm$ Ramp	$\pm 85^\circ$

3-68. Modify Keys.

3-69. The numerical data of any parameter may be changed by use of the MODIFY keys. First press the prefix key of the parameter to be modified, placing the

information in the display. Next, press the $\leftarrow$ or $\rightarrow$

key to move the bright digit cursor to the digit you want

to modify. Then press the $\uparrow$ or $\downarrow$ key momentarily

to increase or decrease the value of that digit by 1. If the modify key is held, the digit will continue to increment or decrement after a slight delay. As the modified digit passes 9 (incrementing) or 0 (decrementing) the digit to its left will increment or decrement.

3-70. Store and Recall.

3-71. An entire program may be stored in any one of 10 registers by pressing the "STORE 0-9" key, then the register number. This stores all the information that is in the current program memory. Other programs may then be entered. All stored information is lost when power is removed from these circuits by setting the POWER switch to STBY or disconnecting ac power from the instrument.

NOTE

Any phase information stored is invalid when recalled because the instrument performs an amplitude calibration on RECALL. Phase relationship between the output signal and the reference is not maintained when AMPTD CAL occurs.

3-72. OPERATOR'S CHECKS.

3-73. The following checks provide the operator with a means of determining whether the instrument is operational. They are not intended to verify any specifications. If the instrument fails any of these checks, it should be referred to qualified service personnel for repair.

3-74. Self Test.

3-75. Press the blue prefix key, then SELF TEST (AMPTD CAL). All the front panel display and annunciator LED's should light for approximately two seconds, then the instrument performs an automatic calibration of the sine, square, and triangle functions and the display indicates momentarily whether each test passed or failed. The dc offset is also checked in these tests.

NOTE

If the display reads OSC FAIL at any time, the frequency synthesis circuits are not functioning properly. Refer the instrument to qualified service personnel for repair.

3-76. Output Checks.

3-77. An oscilloscope (-hp- 1740A or equivalent) is required for these checks. Connect the 3325A output through a 50-ohm feedthru termination (-hp- 11048C) to the oscilloscope input (input dc coupled), or set the 1740A input switch to 50 ohms.

FUNCTIONS

- a. Make the following 3325A keyboard selections:

FUNCTION..... Sine
FREQUENCY..... 2 kHz
AMPLITUDE..... 10 V p-p

- b. Set the oscilloscope controls as follows:

Vertical..... 5 V/div
Horizontal..... 0.5 ms/div
Trigger..... Auto

- c. Adjust oscilloscope controls for a stable display, which should show a sine wave approximately two divisions peak-to-peak and one cycle per division.

d. Select square wave, triangle, positive slope ramp, and negative slope ramp and verify that each function indicates the same frequency and peak-to-peak amplitude.

AMPLITUDE AND DC OFFSET

e. Set the 3325A as follows:

FUNCTION.....Square
FREQUENCY.....2 kHz
AMPLITUDE.....10 V p-p

f. Set the oscilloscope controls as follows:

Vertical.....2 V/div
Horizontal.....0.5 ms/div
Trigger.....Auto

g. Oscilloscope display should show one square wave per division, 5 divisions peak-to-peak vertical. This checks the output with no attenuation. Actual display will depend greatly upon the accuracy of the oscilloscope amplifiers and display.

h. Change 3325A amplitude to 1 V p-p, and change oscilloscope vertical to .2 V/div. Oscilloscope display should again be 5 divisions peak-to-peak. This checks the $\div 3$ attenuator section.

i. Change 3325A amplitude to 500 mV p-p, and change oscilloscope vertical to .1 V/div. Oscilloscope display should be 5 divisions peak-to-peak. This checks the $\div 10$ attenuator section.

j. Change 3325A amplitude to 50 mV p-p, and change oscilloscope vertical to .01 V/div. The square wave display should be 5 divisions peak-to-peak. This checks the $\div 100$ attenuator section.

k. Press the 3325A SQUARE WAVE FUNCTION key to remove the square wave output. The indicator in the DC OFFSET Entry key should light and the 3325A display should show 0.0 mV.

l. Set the oscilloscope vertical control to 2 V/div. Ground the input and set the trace to the center line. Set input to dc coupled.

m. Enter 5 V offset in the 3325A. The oscilloscope trace should be 2.5 divisions above the center line. Enter -5 V offset in the 3325A. The oscilloscope trace should go to 2.5 divisions below the center line.

n. Enter 0 V offset in the 3325A. Trace should be on the center line.

FREQUENCY

o. Set the 3325A as follows:

FUNCTION.....Sine
FREQUENCY.....100 Hz
AMPLITUDE.....10 V p-p

p. Set the oscilloscope controls as follows:

Vertical.....2 V/div
Horizontal.....1 ms/div

q. Oscilloscope display should show one cycle of sine wave, which should be free of any apparent irregularities.

r. Enter 20 MHz in the 3325A. Change oscilloscope horizontal to .05 μ s/div. Oscilloscope should display one cycle of sine wave per division.

HIGH VOLTAGE OUTPUT (OPTION 002)

s. Remove the 50-ohm feedthru termination between the 3325A output and the oscilloscope input. Press the key in the lower right corner of the 3325A front panel to select the High Voltage output.

t. Set the 3325A as follows:

FUNCTION.....Sine
FREQUENCY.....2 kHz
AMPLITUDE.....40 V p-p

u. Set the oscilloscope controls as follows:

Vertical.....10 V/div
Horizontal.....0.5 ms/div

v. The oscilloscope display should show a sine wave four divisions peak-to-peak, one cycle per division. This checks the high voltage output amplifier.

3-78. OPERATOR'S MAINTENANCE.

3-79. Maintenance by the operator is limited to cleaning or replacing the rear panel fan filter, or replacing the ac line fuse on the rear panel. Generally, if the ac line fuse requires replacement there is a failure within the instrument, which should be referred to qualified service personnel. Disconnect the ac line cord before replacing the fuse. Be sure to use the correct replacement fuse:

Nominal Line Voltage	Fuse	-hp- Part No.
100/120 V	1 A	2110-0001
220/240 V	0.5 A	2110-0012

3-80. The fan filter should be inspected frequently and cleaned or replaced as necessary to allow free flow of air. To remove the filter, disconnect ac power from the instrument and remove the four nuts that secure the filter retainer. Remove the filter and wash thoroughly with soapy water, rinse clean, and air dry.

3-81. HP-IB OPERATION.

3-82. The Model 3325A is remotely controlled by means of the Hewlett-Packard Interface Bus (HP-IB).

The following information gives a general description of the HP-IB and defines the terms, concepts, and messages used in an HP-IB system. It also lists the capabilities and requirements for programming the 3325A. Program examples using a specific Hewlett-Packard calculator as the system controller may be found in the Supplemental Programming Information, Appendix 3-A at the rear of this section.

NOTE

HP-IB is Hewlett-Packard Company's implementation of IEEE Standard 488-1975, "Standard Digital Interface for Programmable Instrumentation."

3-83. General HP-IB Description.

3-84. The HP-IB is a parallel bus of 16 active signal lines grouped into three sets according to function, to interconnect up to 15 instruments. Figure 3-3 is a diagram of the interface connections and bus structure.

3-85. Eight signal lines form the first set and are termed "data" lines. The data lines carry coded messages which represent addresses, program data, measurements, and status bytes. The same data lines are used for input and

output messages in bit-parallel, byte-serial form. Normally, a seven-bit ASCII code represents each piece (byte) of data, leaving the eighth bit available for parity checking.

3-86. Data transfer is controlled by means of an interlocked "handshake" technique which permits data transfer (asynchronously) at the rate of the slowest device participating in that particular conversation. The three data byte transfer control lines which implement the handshake form the second set of lines.

3-87. The remaining five general interface management lines form the third set and are used in such ways as activating all the connected devices at once, clearing the interface, etc. Table 3-5 defines each of the management lines.

3-88. Definition of HP-IB Terms and Concepts.

Byte - A unit of information consisting of eight binary digits (bits).

Device - Any unit that is compatible with the IEEE Standard 488-1975.

Device Dependent - 1. An action a device performs in response to information sent on the HP-IB. The action is characteristic of an individual device and may vary from device to device. 2. The data required to communicate with a particular device.

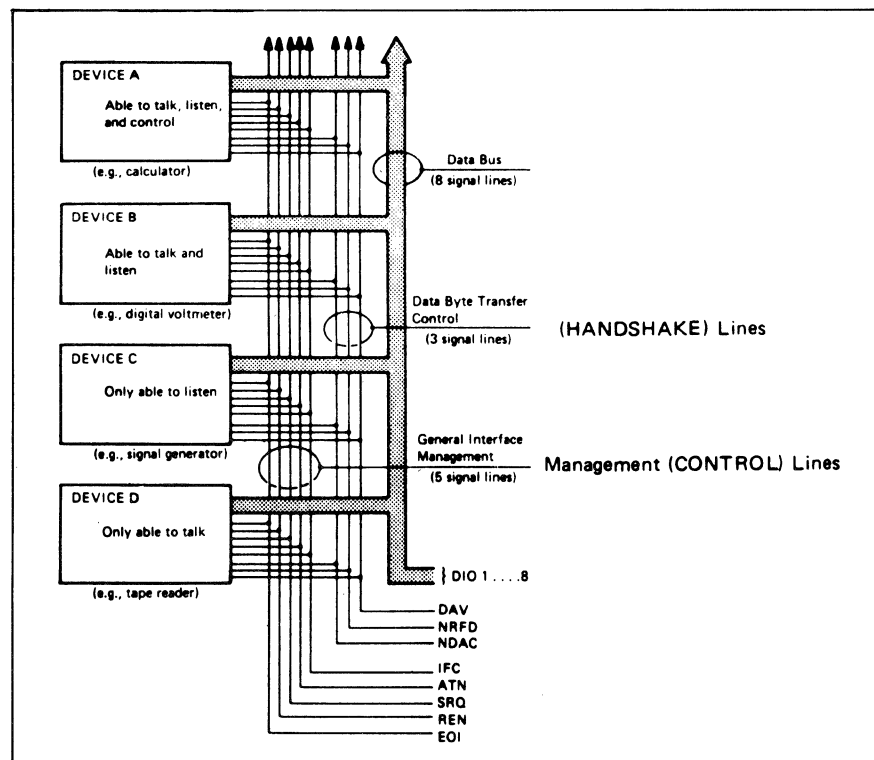


Figure 3-3. Interface Connections and Bus Structure.

Table 3-5. General Interface Management Lines.

Name	Mnemonic	Description
Attention	ATN	Enables a device to interpret data on the bus as a controller command (command mode) or data transfer (Data Mode).
Interface Clear	IFC	Initializes the HP-IB system to an idle state (no activity on the bus.)
Service Request	SRQ	Alerts the controller to a need for communication.
Remote Enable	REN	Places instruments under remote program control.
End Or Identify	EOI	Indicates last data transmission during a data transfer sequence; used with ATN to poll devices for their status.

Operator - The person that operates either the system or any device in the system.

Address - The characters sent by a controller to specify which device will send information on the bus and which device(s) will receive information. A device may also have its address fixed so that it may only receive information (listen only) or only send information (talk only).

Polling - Polling is a means by which a controller can identify a device that needs interaction with it. The controller may poll devices for their operational condition one at a time, which is termed a serial poll, or as groups of devices simultaneously, which is termed a parallel poll.

3-89. Basic Device Communication Capability.

3-90. Devices which communicate along the interface bus fall into three basic categories.

Talkers - Devices which send information on the bus when they have been addressed.

Listeners - Devices which receive information sent on the bus when they have been addressed.

Controllers - Devices that can specify the talker and listener(s) for an information transfer. The controller can be an active controller or a system controller. The active controller is defined as the current controlling device on the bus. The system controller can take control of the bus even if it is not the active controller. Each system can have only one system controller, even if several controllers have system control capability.

3-91. Message Definitions.

3-92. Information is transferred on the HP-IB from one device to one or more other devices in quantities

called "messages". Some of the messages consist of two basic parts, the address portion and the information portion. Others are general messages to all devices. Messages can be classified into twelve types, which are referred to as "meta messages". These are defined in Table 3-6. A block diagram presentation of meta messages and their implementation will be found in Appendix A-3 at the rear of this section.

NOTE

The meta message in itself is not a program code or an HP-IB command. It is only intended as a tool to translate a program written as an algorithm into the controller's code.

3-93. 3325A Response to Messages.

3-94. The 3325A is capable of implementing only those messages indicated in Table 3-7. In order for those messages to be implemented, certain bus actions are required, which are shown in the Interface Functions column.

3-95. HP-IB Work Sheet.

3-96. A work sheet is provided at the end of this section for listing the address and message capabilities of each instrument in your HP-IB system. When this sheet is filled out, it will provide a summary of the system capabilities.

3-97. HP-IB Addressing.

3-98. Certain messages require that a specific talker and listener be designated. Each instrument on the bus has its own distinctive listen and/or talk address which distinguishes it from other devices. The 3325A receives programming instructions when addressed to listen. When addressed to talk, it will respond to the instructions it received prior to being addressed to talk, such as an interrogation or serial poll.

3-99. Addressing usually takes the form of "universal unlisten, device talk, device(s) listen". The universal unlisten command removes all listeners from the bus, allowing only the listener(s) designated by the device(s) listen parameter to receive information. The information is sent by the talker designated by the device talk parameter. The system controller may designate itself as either talker or listener.

3-100. 3325A REMOTE PROGRAMMING.

3-101. 3325A HP-IB Capabilities.

3-102. Table 3-8 lists the HP-IB capabilities of the 3325A, which are compatible with IEEE Standard 488-1975.

Table 3-6. Definition of Meta Messages.

Message	Definition	Message	Definition
Data	The actual information (binary bytes) which is sent from a talker to one or more listeners. The information or data can be in a numeric form or a string of characters.	Status Byte	A byte that represents the status of a single device. One bit indicates whether the device sent the required service message and the remaining 7 bits indicate operational conditions defined by the device. This byte is sent from the talking device in response to a "Serial Poll" operation performed by a controller.
Trigger	The trigger message causes the listening device(s) to perform a device-dependent action.	Status Bit	A byte that represents the operational conditions of a group of devices on the bus. Each device responds on a particular bit of the byte thus identifying a device dependent condition. This bit is typically sent by devices in response to a parallel poll operation. The status bit message can also be used by a controller to specify the particular bit and logic level that a device will respond with when a parallel poll operation is performed. Thus, more than one device may respond on the same bit.
Clear	A clear message will cause a device(s) to return to a pre-defined device-dependent state.	Pass Control	This message transfers the bus management responsibilities from the active controller to another controller.
Remote	The remote message causes the listening device(s) to switch from local front panel control, to remote program control. This message remains in effect so that devices subsequently addressed to listen will go into remote operation.	Abort	The system controller sends the abort message to unconditionally assume control of the bus from the active controller. The message will terminate all bus communications but does not implement the clear message.
Local	This message clears the remote message from the listening device(s) and returns the device(s) to local front panel control.		
Local Lockout	The local lockout message is implemented to prevent the device operator from manually inhibiting remote program control.		
Clear Lockout and Set Local	This message causes all devices to be removed from the local lockout mode and revert to local. It will also clear the remote message for all devices.		
Require Service	A device can send this message at any time to signify that it needs some type of interaction with the controller. The message is cleared by the device's status byte message if it no longer requires service.		

3-103. Developing an HP-IB Program.

3-104. Basically, the 3325A is programmed remotely in the same manner as it is programmed manually. The sequence in which the various parameters are programmed is not important. At the end of this section (III) there is a summary of the HP-IB Programming Codes. This chart may be removed from the manual and/or copied to be used as a programming reference.

NOTE

It may be necessary to refer to some paragraphs on manual operation for descriptions of certain signals and requirements.

3-105. Several steps are needed to develop an HP-IB program.

a. Completely define the operation(s) the system is required to perform.

b. Write the program in flowchart or algorithm form. (An algorithm may be defined as a fixed step-by-step procedure for finding a solution to a problem.) Use the key words for meta messages shown in Table 3-6 in developing the program. The twelve key words are repeated here for reference.

Data
*Trigger
Clear
Remote
Local
Local Lockout
Clear Lockout and Set Local
Require Service

Table 3-7. 3325A Implementation of Messages.

Message	Implementation *	Interface Functions **		3325A Response
		Sender	Receiver	
Data	SR	T, SH	L ⁿ , AH	Will send or receive as instructed
Trigger	NA	T, SH	L ⁿ , AH	None
Clear-ID	R	C, SH	DC ⁿ , L, AH	Device Clear sets 3325A to initial turn-on conditions. See Para. 3-8.
Clear-All	R	C, SH	DC ^h , AH	
Remote	R	C _s , SH	RL ⁿ , L, AH RL, AH	Goes to Remote. Can be set to Local by LOCAL key.
Local	R	C _s , SH	RL ⁿ , L, AH	Goes to Local.
Local Lockout	R	C, SH	RL, AH	Goes to Remote. Cannot be set to Local by LOCAL key.
Clear Lockout and Set Local	R	C _s	RL	Goes to Local from Local Lockout.
Require Service	S	SR ⁿ	C	Sets SRQ True.
Status Byte	S	SR ⁿ , T, SH	L ⁿ , AH	Sends byte which indicates if service required and reason.
Status Bit	NA	pp ^h	C	None
Pass Control	NA	C _A , SH	C _B , T, AH	None
Abort	R	C _s		Unaddress
*S = Send Only R = Receive Only SR = Send and Receive NA = Not Applicable **SH = Source Handshake AH = Acceptor Handshake T = Talker (includes TE = Extended Talker) L = Listener (includes LE = Extended Listener) SR = Service Request RL = Remote/Local PP = Parallel Poll DC = Device Clear DT = Device Trigger C = Any Controller C _N = A specific controller (for example, C _A , C _B) C _s = The System Controller X ^h = Indicates message can be sent to/by one or more devices simultaneously				

Status Byte

*Status Bit

*Pass Control

Abort

*Not implemented by the 3325A

NOTE

The meta message in itself is not a program code or an HP-IB command. It is only intended as a tool to translate a program written as an algorithm into the controller's code.

Table 3-8. Interface Functions.

Code	Function
SH1	Source handshake capability
AH1	Acceptor handshake capability
T6	Basic talker; Serial Poll; Unaddressed to talk if addressed to listen
L3	Basic listener; Listen Only; Unaddressed to listen if addressed to talk
SR1	Service Request capability
RL1	Remote/Local capability
PP0	No parallel poll capability
DC1	Device clear capability
DT0	No device trigger capability
C0	No controller capability
E1	Open collector bus drivers

c. Define the operation in program codes that the instrument can use. Each instrument has its own set of program codes which are ASCII characters. The 3325A program codes are shown beginning with Paragraph 3-120 or Table 3-9.

d. Convert the program into the controller's language. The conversion information is supplied with each controller. For example, the -hp- 9825A Calculator Extended I/O Manual provides a chart for program code conversion.

NOTE

Examples for controlling the 3325A with a specific Hewlett-Packard calculator are provided in the Supplemental Programming Information, Appendix B-3 at the rear of this section.

3-106. Block diagrams and explanations of the meta messages that apply to the 3325A are shown in Appendix A-3 at the rear of this section.

3-107. Universal and Addressed Commands.

3-108. The 3325A will respond to the following universal and addressed commands, which are sent in the command mode (ATN true).

Mnemonic	Command	ASCII Code
Universal:		
*DCL	Device Clear	DC4
LLO	Local Lockout	DC1
MLA	My Listen Address	(selectable)
MTA	My Talk Address	(selectable)
SPD	Serial Poll Disable	EM
SPE	Serial Poll Enable	CAN
UNL	Unlisten	?
UNT	Untalk	—
Addressed:		
GTL	Go to Local	SOH
*SDC	Selected Device Clear	EOT

*DCL and SDC commands set the 3325A to its initial turn-on conditions (see Paragraph 3-8) and cause an AMPTD CAL operation. Any data in the HP-IB input buffer is lost. The storage registers, SRQ masking, and the status byte are not affected.

3-109. Placing the 3325A in Remote.

3-110. The 3325A will go to Remote when ATN is true, REN is true, and it receives its listen address.

3-111. The 3325A Address.

3-112. The 3325A address is normally set at the factory to:

	ASCII Character	5-Bit Octal	(5-Bit Octal Equivalent)	
			Decimal	Hexadecimal
Listen	I	21	17	11
Talk	Q	21	17	11

The 3325A can be made to display its address in decimal code by pressing the blue prefix key and the BUS ADRS (LOCAL) key.

NOTES

1. All programming is shown in ASCII code.

2. Table 3-9 is a summary of the 3325A program data messages and program times. Table 3-10 lists program codes in binary, octal, decimal, and hexadecimal. At the end of this section (III) there is also a summary of the HP-IB programming codes. This chart may be removed from the manual and/or copied to be used as a programming reference.

3. The following front panel key actions cannot be remotely programmed:

Modify group

Sweep bandwidth $\times 2$

Sweep bandwidth $\div 2$

Set sweep center frequency to marker frequency

Display bus address

Clear display

4. The 3325A must be set to REMOTE and addressed to LISTEN before it will accept device dependent data messages.

3-113. 3325A Data Message Formats.

3-114. The following are valid programming strings (data messages) for the 3325A:

Mnemonic, Data, Delimiter, EOS

Mnemonic, Data, EOS

Mnemonic, EOS

I, Mnemonic, EOS

Where I is the ASCII character I and EOS is the end-of-string character, which is required for Data Transfer Mode 2 (see following paragraphs). Valid EOS characters are:

LF = Line Feed = 12 octal

* = Asterisk = 52 octal

Table 3-9. Summary of 3325A Programming (ASCII Characters). **

Parameter or Operation	Mnemonics ASCII Code	Data	ASCII Code Delimiters	Approximate Programming Time*
Data Transfer Mode Data Mode 1 Data Mode 2	= MD = MD	1 2	NA	MD = 4.5 ms
Function	= FU	0 = DC Only 1 = Sine 2 = Square 3 = Triangle 4 = Positive Ramp 5 = Negative Ramp	NA	FU = 1500 ms
Frequency	= FR	≤ 11 Digits and Decimal	HZ = Hertz KH = KiloHertz MH = Megahertz	FR = 7.0 ms Each digit or decimal = 2.8 ms HZ, KH, or MH = 12.5 ms
Amplitude	= AM	≤ 4 Digits and Decimal. Also – sign if negative dBm. + sign is valid but not required.	VO = Volts (p-p) MV = Millivolts (p-p) VR = Volts rms MR = Millivolts rms DB = dBm	AM = 6.8 ms Each digit, decimal or decimal = 2.8 ms VO or MV = 90 ms VR or MR = 130 ms DB = 250 ms
DC Offset	= OF	≤ 4 Digits and Decimal. Also – sign if negative dc offset. + sign is valid but not required.	VO = Volts MV = Millivolts	OF = 6.8 ms Each digit, decimal, or – sign = 2.8 ms VO or MV = 82 ms
Phase	= PH	≤ 4 Digits – minus sign	DE = Degrees	PH = 5 ms; DE = 28 ms Each digit and – sign = 2.8 ms
Sweep Start Frequency Sweep Stop Frequency Sweep Marker Frequency	= ST = SP = MF	≤ 11 Digits and Decimal	HZ = Hertz KH = KiloHertz MH = Megahertz	ST, SP, or MF = 7.0 ms Each digit or decimal = 2.8 ms HZ, KH, or MH = 10.3 ms
Sweep Time	= TI	≤ 4 Digits and Decimal	SE = Seconds	TI = 5.5 ms; SE = 7.0 ms Each digit and decimal = 2.8 ms
Sweep Mode Linear Logarithmic	= SM	1 2	NA	SM = 4.5 ms
Rear or Front Panel Output Front Panel Rear Panel	= RF	1 2	NA	RF = 44.5 ms
Store Program Recall Program	= SR = RE	1 Digit, 0-9	NA	SR = 11 ms; RE = 1700 ms
Execution Functions Assign Zero Phase Perform Auto-Cal Start Single Sweep Start Continuous Sweep Perform Self-Test	= AP = AC = SS = SC = TE	NA NA	NA NA	AP = 5.2 ms AC = 1500 ms SS = 300 ms SC = 300 ms TE = 10,000 ms
Interrogate Program Error	= IER	NA	NA	IER = 11.5 ms
Interrogate Entry Parameters Frequency Amplitude Offset Phase Sweep Start Frequency Sweep Stop Frequency Sweep Marker Frequency Sweep Time	= IFR = IAM = IOF = IPH = IST = ISP = IMF = ITI	NA	NA	IFR = 10 ms IAM = 9.8 ms IOF = 9.8 ms IPH = 8 ms IST = 10 ms ISP = 10 ms IMF = 10 ms ITI = 8.5 ms
Interrogate Function	= IFU	NA	NA	IFU = 1603 ms
Mask Service Requests	= MS	See Para. 3-144	NA	MS = 4.5 ms
Binary (ON/OFF) Functions High Voltage Output Amplitude Modulation Phase Modulation	= HV = MA = MP	OFF = 0 ON = 1	NA	HV = 48 ms MA = 7.0 ms MP = 7.0 ms

Table 3-10. Programming Codes.

Instruction	ASCII Characters	Binary Code	Octal Code	Decimal Code	Hexadecimal Code
Entry Frequency	F	1 0 0 0 1 1 0	106	70	46
	R	1 0 1 0 0 1 0	122	82	52
Amplitude	A	1 0 0 0 0 0 1	101	65	41
	M	1 0 0 1 1 0 1	115	77	4D
Offset	O	1 0 0 1 1 1 1	117	79	4F
	F	1 0 0 0 1 1 0	106	70	46
Phase	P	1 0 1 0 0 0 0	120	80	50
	H	1 0 0 1 0 0 0	110	72	48
Sweep Start Frequency	S	1 0 1 0 0 1 1	123	83	53
	T	1 0 1 0 1 0 0	124	84	54
Stop Frequency	S	1 0 1 0 0 1 1	123	83	53
	P	1 0 1 0 0 0 0	120	80	50
Marker Frequency	M	1 0 0 1 1 0 1	115	77	4D
	F	1 0 0 0 1 1 0	106	70	46
Time	T	1 0 1 0 1 0 0	124	84	54
	I	1 0 0 1 0 0 1	111	73	49
Start Continuous	S	1 0 1 0 0 1 1	123	83	53
	C	1 0 0 0 0 1 1	103	67	43
Start Single (must be sent twice)	S	1 0 1 0 0 1 1	123	83	53
	S	1 0 1 0 0 1 1	123	83	53
Sweep Mode	S	1 0 1 0 0 1 1	123	83	53
	M	1 0 0 1 1 0 1	115	77	4D
Numerical Data					
0	0	0 1 1 0 0 0 0	060	48	30
1	1	0 1 1 0 0 0 1	061	49	31
2	2	0 1 1 0 0 1 0	062	50	32
3	3	0 1 1 0 0 1 1	063	51	33
4	4	0 1 1 0 1 0 0	064	52	34
5	5	0 1 1 0 1 0 1	065	53	35
6	6	0 1 1 0 1 1 0	066	54	36
7	7	0 1 1 0 1 1 1	067	55	37
8	8	0 1 1 1 0 0 0	070	56	38
9	9	0 1 1 1 0 0 1	071	57	39
.(decimal)	.	0 1 0 1 1 1 0	056	46	2E
– (minus)	–	0 1 0 1 1 0 1	055	45	2D
Data Suffix (Delimiter) Hertz	H	1 0 0 1 0 0 0	110	72	48
	Z	1 0 1 1 0 1 0	132	90	5A
Kilohertz	K	1 0 0 1 0 1 1	113	75	4B
	H	1 0 0 1 0 0 0	110	72	48
Megahertz	M	1 0 0 1 1 0 1	115	77	4D
	H	1 0 0 1 0 0 0	110	72	4A
Volts (p-p or dc)	V	1 0 1 0 1 1 0	126	86	56
	O	1 0 0 1 1 1 1	117	79	4F
Millivolts (p-p or dc)	M	1 0 0 1 1 0 1	115	77	4D
	V	1 0 1 0 1 1 0	126	86	56
Volts rms	V	1 0 1 0 1 1 0	126	86	56
	R	1 0 1 0 0 1 0	122	82	52
Millivolts rms	M	1 0 0 1 1 0 1	115	77	4D
	R	1 0 1 0 0 1 0	122	82	52
dBm	D	1 0 0 0 1 0 0	104	68	44
	B	1 0 0 0 0 1 0	102	66	42
Degrees	D	1 0 0 0 1 0 0	104	68	44
	E	1 0 0 0 1 0 1	105	69	45
Seconds	S	1 0 1 0 0 1 1	123	83	53
	E	1 0 0 0 1 0 1	105	69	45
Store	S	1 0 1 0 0 1 1	123	83	53
	R	1 0 1 0 0 1 0	122	82	52
Recall	R	1 0 1 0 0 1 0	122	82	52
	E	1 0 0 0 1 0 1	105	69	45

Table 3-10. Programming Codes (Cont'd).

Instruction	ASCII Characters	Binary Code	Octal Code	Decimal Code	Hexadecimal Code
High Voltage Output	H	1 0 0 1 0 0 0	110	72	48
	V	1 0 1 0 1 1 0	126	86	56
Modulation-Amplitude	M	1 0 0 1 1 0 1	115	77	4D
	A	1 0 0 0 0 0 1	101	65	41
Modulation-Phase	M	1 0 0 1 1 0 1	115	77	4D
	P	1 0 1 0 0 0 0	120	80	50
Rear or Front Output	R	1 0 1 0 0 1 0	122	82	52
	F	1 0 0 0 1 1 0	106	70	46
Data Transfer Mode	M	1 0 0 1 1 0 1	115	77	4D
	D	1 0 0 0 1 0 0	104	68	44
Assign Zero Phase Reference	A	1 0 0 0 0 0 1	101	65	41
	P	1 0 1 0 0 0 0	120	80	50
Perform Auto Cal.	A	1 0 0 0 0 0 1	101	65	41
	C	1 0 0 0 0 1 1	103	67	43
Perform Self Test	T	1 0 1 0 1 0 0	124	84	54
	E	1 0 0 0 1 0 1	105	69	45
Mask SRQ	M	1 0 0 1 1 0 1	115	77	4D
	S	1 0 1 0 0 1 1	123	83	53
Interrogate (Parameter)	I	1 0 0 1 0 0 1	111	73	49
Interrogate Error	I	1 0 0 1 0 0 1	111	73	49
	E	1 0 0 0 1 0 1	105	69	45
	R	1 0 1 0 0 1 0	122	82	52
EOS (End of String) Line Feed Asterisk	LF	0 0 0 1 0 1 0	12	10	A
	*	0 1 0 1 0 1 0	52	42	2A

All spaces (40 octal), carriage returns (15 octal), commas (54 octal), and all lower case alphabets are ignored by the 3325A.

NOTE

A program string may program one parameter or all parameters. For example, the string "FU2FR10KHAM3V0" programs the following:

*FU2 = Square wave function
FR10KH = 10 kHz
AM3V0 = 3 V p-p*

The EOS character should follow the complete string, or a maximum of 48 characters (see Paragraphs 3-115 through 3-118).

3-115. Data Transfer Mode.

3-116. The 3325A accepts data from the HP-IB in either of two modes. If speed of communication is a critical factor on your HP-IB system, Mode 2 is preferable. The characteristics of the two modes are:

Data Mode 1. The 3325A turns on in Data Mode 1. In this mode, each device dependent character (byte) is processed when received.

Line feeds and Asterisks (EOS characters) are ignored. No other device dependent data communications are permitted on the bus until the entire 3325A program string has been accepted and all but the last character processed.

Data Mode 2. Device dependent characters are accepted and stored in an internal buffer and not processed until the EOS character is received or the buffer is filled (48 bytes). Consequently, other communications on the bus are permitted after the program string has been accepted (at the rate of approximately 150 to 200 microseconds per character). If the program string contains 48 characters or more, the 3325A will hold up the bus while it processes the 48 characters before accepting and storing the rest of the string. Because the instrument turns on in Data Mode 1, Mode 2 must be programmed remotely. It will then remain in Mode 2 until Mode 1 is programmed or until the POWER switch is set to STBY.

3-117. While the 3325A is processing data it will accept and respond to universal commands. For this reason, when operating in Mode 2, the controller can send a program string (48 characters or less) to the 3325A, and

while this data is being processed the controller can unaddress the 3325A to listen and then communicate with another device. However, if the string is more than 48 characters, the bus will be held up until the first 48 characters have been processed and the remaining characters accepted. In order for the bus to be used during 3325A processing time for communication between other devices, a program string greater than 48 characters should be divided and an EOS character sent after (or at a convenient place before) the 48th byte. The remaining program can then constitute a second string. While the 3325A is processing input information, a "Busy" flag is set in the status byte (see Paragraph 3-136). This flag can be used to determine when the 3325A has finished processing.

NOTE

The 3325A will handshake bus communications even though the POWER switch is set to STBY. This will not interfere with the operation of the bus unless it was set to STBY while addressed to talk. Before it is set to STBY, make sure it is not addressed to talk, or else disconnect the HP-IB cable from the 3325A. The addressed to talk condition can be cleared by an IFC command, even when the 3325A is in Standby.

3-118. Programming Data Transfer Mode.

3-119. Instructions for programming Data Transfer Mode are included in Paragraph 3-126.

3-120. Programming Entry Parameters.

3-121. The 3325A entry parameters are:

Frequency
Amplitude
Offset
Phase
Sweep Start Frequency
Sweep Stop Frequency
Sweep Marker Frequency
Sweep Time

The programming syntax for these parameters is:

Mnemonic, Data, Delimiter, EOS

NOTE

All program codes are shown in ASCII characters.

Valid mnemonics:

FR = Frequency
AM = Amplitude
OF = Offset

PH = Phase
ST = Sweep Start Frequency
SP = Sweep Stop Frequency
MF = Sweep Marker Frequency
TI = Sweep Time

Valid data:

0 thru 9 = ASCII numerics (if too many digits are sent, the extra digits will be ignored or rounded)

+ = ASCII plus sign (plus sign is accepted but not required)

- = ASCII minus sign (minus sign will be ignored if sent for parameters that cannot be negative)

. = ASCII decimal (floating decimal entries not valid)

Valid delimiters:

HZ = Hertz
KH = Kiloherzt
MH = Megahertz
VO = Volts (peak-to-peak or dc)
MV = Millivolts (peak-to-peak or dc)
VR = Volts rms
MR = Millivolts rms
DB = dBm
DE = Degrees
SE = Seconds

NOTE

When operating in Data Mode 1, an EOS character is not required. When in Mode 2, the EOS character should not be sent until the end of the program string (or after 48 bytes; see Paragraph 3-117).

3-122. Programming Waveform Function.

3-123. The selectable functions are:

DC only
Sine wave
Square wave
Triangle wave
Positive Slope Ramp
Negative Slope Ramp

The programming syntax for selecting function is:

Mnemonic, Data, EOS

Valid mnemonic:

FU = Function

Valid data:

- Ø = Function off (dc only)
- 1 = Sine
- 2 = Square
- 3 = Triangle
- 4 = Positive Slope Ramp
- 5 = Negative Slope Ramp

3-124. Programming Binary (On or Off) Functions.

3-125. The programmable binary functions are:

- High Voltage Output (Option 002)
- Amplitude Modulation
- Phase Modulation

The programming syntax for binary functions is:

Mnemonic, Data, EOS

Valid mnemonics:

- HV = High Voltage Output (If the 3325A receives the HV mnemonic but does not have the high voltage option, SRQ (if enabled) and an error code will be generated. See Paragraph 3-134.)
- MA = Modulation – Amplitude
- MP = Modulation – Phase

Valid data:

- Ø = Off
- 1 = On

NOTE

The rear panel signal output is inactive (no internal signal connection) if the instrument has the High Voltage Output Option 002 installed. Instructions are given in the Operating and Service Manual, Section VIII, Service Group M, for activating the rear panel signal output in one of two ways: 1) Placing the standard/high voltage output on the rear panel only, disconnecting the front panel signal output, or 2) Disabling the high voltage output and enabling the standard front/rear output configuration.

3-126. Programming Selection Functions.

NOTE

The selection functions are similar to binary functions, but instead of ON or OFF states, selection is made between two mutually exclusive operations.

3-127. The programmable selection functions are:

- Rear Output/Front Output
- Linear Sweep/Logarithmic Sweep
- Data Transfer Mode

The programming syntax for the selection functions is:

Mnemonic, Data, EOS

Valid mnemonics:

- RF = Rear or Front Output
- SM = Sweep Mode
- MD = Data Transfer Mode

Valid data for RF is:

- 1 = Select Rear Output
- 2 = Select Front Output (If the 3325A receives the RF mnemonic but does not have rear output capability (Option 002, for example) SRQ (if enabled) and an error code will be generated. See Paragraph 3-134.)

Valid data for SM is:

- 1 = Linear Sweep (The 3325A turns on in Linear Sweep function. This function need not be programmed except to change from Linear to Log Sweep or to return to Linear.)
- 2 = Logarithmic Sweep

Valid data for MD is:

- 1 = Data Mode 1 (The 3325A turns on in Data Mode 1. This function need not be programmed if it is desired to remain in Data Mode 1.)
- 2 = Data Mode 2

3-128. Programming Execution Functions.

3-129. The programmable execution functions are:

- Assign Zero Phase Reference
- Perform Amplitude Calibration
- Start Single Sweep
- Start Continuous Sweep
- Perform Self Test

The programming syntax for execution functions is:

Mnemonic, EOS

Valid mnemonics:

- AP = Assign Zero Phase Reference
- AC = Perform Amplitude Calibration
- SS = Start Single Sweep

SC = Start Continuous Sweep
TE = Perform Self Test

NOTES

1. *The Start Single mnemonic must be sent twice (SSSS). The first SS sets the output (and display) to the start frequency, and the second SS starts the sweep.*

2. *While the 3325A is in Continuous Sweep mode, if it receives the mnemonics SC, SS, FR, PH, AC, AP, or TE, it will stop sweeping. It must receive SC again in order to resume continuous sweeping; or if a single sweep is to be programmed, SSSS is required.*

3. *The "Busy" flag (bit 7 in the status byte, see Paragraph 3-138) will be "1" for the duration of a Self Test operation. After Self Test, the 3325A returns to the previously programmed conditions, except that if a sweep was in progress the sweep will remain stopped.*

3-130. Programming Amplitude Units Conversion.

3-131. The programming syntax for converting amplitude units (Vp-p, Vrms, dBm) is:

Mnemonic, Delimiter, EOS

Mnemonic = AM = Amplitude

Delimiter = The units to which you want to convert:

VO = Vp-p
MV = mVp-p
VR = Vrms
MR = mVrms
DB = dBm

Example: If amplitude was programmed in Vp-p, it may be converted to dBm by programming "AMDB". If amplitude was the last parameter programmed and is shown in the display, only the delimiter "DB" needs to be programmed.

3-132. Programming Storage Registers.

3-133. The data that will be stored includes the current program of Entry Parameters, Function (Waveform), Binary Functions, and Selection Functions. The storage register functions are:

Store Data in Register N
Recall Data from Register N

The programming syntax for storage register functions is:

Mnemonic, Data, EOS

Valid mnemonics:

SR = Store
RE = Recall

Valid data:

0 thru 9 = ASCII numerics specifying register number

NOTES

1. *If no data has been stored in a register, the recall command for that register will be ignored.*

2. *An amplitude calibration is performed when a register is recalled.*

3. *The numeric value for the phase is stored, but the phase of the output is not changed when the register is recalled. (Phase may need to be reprogrammed.)*

4. *DCL (Device Clear) and SDC (Selected Device Clear) commands do not affect the storage registers.*

3-134. Service Requests.

3-135. The 3325A will set the SRQ line true for any of the following reasons, if enabled by the SRQ mask (see Paragraph 3-144):

Program String Error
Sweep Started or Sweep Stopped
System Failure (Possible component problem)
Failed Self Test
Failed Amplitude Calibration
External Reference Unlocked
Main Oscillator Unlocked

3-136. Serial Poll.

3-137. When the system controller determines that the SRQ line is true, it may conduct either a Serial Poll or a Parallel Poll to determine which device(s) initiated the Service Request, and the reason(s) for the request. The 3325A responds to a Serial Poll, which is conducted in the following manner:

Controller places ATN true (command mode)
Controller sends Serial Poll Enable (SPE) on lines DIO1-8 (ASCII CAN, binary code ×0011000)

Controller sends 3325A Talk address, controller Listen address
 Controller places ATN false (data mode)
 3325A responds by sending status byte on DIO1-8
 Controller places ATN true (after each device has been polled)
 Controller sends Serial Poll Disable (SPD) on DIO1-8 (ASCII EM, binary code $\times 0011001$)

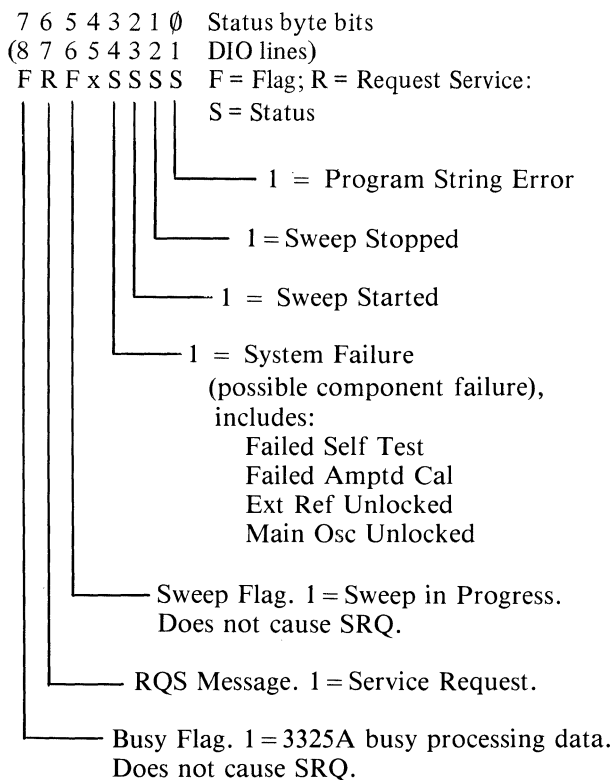
Serial Poll Disable clears the SRQ message originated by the 3325A, resetting bits 0 through 3 and bit 6 in the status byte.

NOTE

Some of the above Serial Poll operations are performed automatically by some controllers in response to certain programming statements. Refer to the programming instructions for your particular controller.

3-138. Status Byte.

3-139. A status byte consists of one 8-bit byte on the HP-IB data lines. A "1" in bit 6 indicates that the 3325A did request service (placed SRQ true), and a "0" in bit 6 indicates that it did not request service. The 3325A status byte contains the following information:



3-140. Busy Flag.

3-141. The Busy Flag (status byte bit 7) is high (1) while the 3325A is processing data. This bit can be monitored

by the controller to determine when the 3325A is ready for more data.

3-142. Sweep Flag.

3-143. The Sweep Flag (bit 5 of the status byte) is high (1) while the 3325A is in the process of sweeping. This bit can be monitored by the controller to determine when the end of a sweep occurs.

3-144. Masking or Enabling Service Requests.

3-145. Bits 3 through 0 in the status byte can be masked so that the corresponding conditions will not cause a service request. However, a "1" will still appear in the status byte if the condition exists, and can be cleared only by a serial poll. At instrument turn-on all SRQ conditions are masked. The programming syntax for masking and enabling SRQ conditions is:

Mnemonic, Data, EOS

Mnemonic = MS

Valid Data is shown in Table 3-11.

3-146. Interrogating Program Errors.

3-147. The "Program Error" service request may result from the following Errors:

ASCII Numeric	Error
1	Entry parameter out of bounds (for example, Freq ≥ 61 MHz)
2	Invalid delimiter
3	Frequency too large for function (for example, Function = Triangle, Freq ≥ 11 kHz)
4	Sweep time too small or too large
5	Offset incompatible with amplitude, or amplitude incompatible with offset
6	Sweep frequency too large for function; Sweep bandwidth too small; Start frequency too small (log sweep); Start frequency greater than stop frequency (log sweep)
7	Unrecognizable mnemonic received
8	Unrecognizable data character received
9	Option does not exist (High Voltage or Rear/Front)

Table 3-11. SRQ Mask/Enable Data.

ASCII Character	Bits 3 thru 0	System Fail Bit 3	Sweep Start Bit 2	Sweep Stop Bit 1	Program Error Bit 0
@	*0000	Mask	Mask	Mask	Mask
A	0001	Mask	Mask	Mask	Enable
B	0010	Mask	Mask	Enable	Mask
C	0011	Mask	Mask	Enable	Enable
D	0100	Mask	Enable	Mask	Mask
E	0101	Mask	Enable	Mask	Enable
F	0110	Mask	Enable	Enable	Mask
G	0111	Mask	Enable	Enable	Enable
H	1000	Enable	Mask	Mask	Mask
I	1001	Enable	Mask	Mask	Enable
J	1010	Enable	Mask	Enable	Mask
K	1011	Enable	Mask	Enable	Enable
L	1100	Enable	Enable	Mask	Mask
M	1101	Enable	Enable	Mask	Enable
N	1110	Enable	Enable	Enable	Mask
O	1111	Enable	Enable	Enable	Enable

* Initial turn-on conditions

The programming syntax for interrogating error is:

Mnemonic, EOS

Mnemonic = IER

After receiving IER, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, CR (ASCII carriage return), LF & EOI (ASCII line feed with EOI sent simultaneously)

Mnemonic = ER

Data = The ASCII numeric corresponding to the first error that occurred (see list above).

If no error occurred, the code returned is 0. When more than one error has occurred, only the code for the first error will be returned. After interrogation, the error code is set to zero until the next error occurs.

3-148. Interrogating Entry Parameters.

3-149. Each entry parameter can be interrogated by the controller to determine its value. The programming syntax for interrogating entry parameters is:

I, Mnemonic, EOI

I = the ASCII character I and indicates interrogation desired.

Valid mnemonics (parameter to be interrogated):

FR = Frequency
AM = Amplitude
OF = Offset

PH = Phase

ST = Sweep Start Frequency

SP = Sweep Stop Frequency

MF = Sweep Marker Frequency

TI = Sweep Time

After receiving a parameter interrogation, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, Delimiter, CR (ASCII Carriage Return), LF & EOI (ASCII Line Feed with EOI sent simultaneously)

Mnemonic = The mnemonic of the parameter being interrogated

Data = 11 digits of ASCII numerics equal to the value of the specified parameter plus decimal point. If the value is negative, the first digit is a minus sign.

Delimiter = The data suffix mnemonic denoting the parameter value (see Paragraph 3-120)

NOTE

Only one parameter can be interrogated by each interrogation message.

3-150. Interrogating Function (Waveform).

3-151. The 3325A may be interrogated by the controller to determine the current function programmed. The programming syntax for interrogating function is:

I, Mnemonic, EOS

I = The ASCII character I and indicates interrogation desired

Mnemonic = FU = Function

After receiving IFU, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, CR (ASCII Carriage Return), LF & EOI (ASCII Line Feed with EOI sent simultaneously)

Mnemonic = FU

Data = One ASCII numeric indicating function as follows:

- 0 = DC Only (Offset)
- 1 = Sine
- 2 = Square
- 3 = Triangle
- 4 = Positive Slope Ramp
- 5 = Negative Slope Ramp

3-152. Interrogating Miscellaneous Parameters.

3-153. The other parameters shown below can be interrogated by the controller to determine their present state. The programming syntax is:

I, Mnemonic, EOS

I = The ASCII character I and indicates interrogation desired

Valid Mnemonics (parameter to be interrogated):

- SM = Sweep Mode
- RF = Rear or Front Output*
- HV = High Voltage Output*
- MA = Amplitude Modulation
- MP = Phase Modulation

*Rear/Front output and High Voltage Output (Option 002) are mutually exclusive. If either RF or HV is interrogated, the mnemonic and data returned will indicate the actual capability of the instrument and its state. For example, if the High Voltage option is present and OFF, HV0 will be returned in response to either IRF or IHV.

After receiving an interrogation, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, CR (ASCII Carriage Return), LF & EOI (ASCII Line Feed with EOI sent simultaneously)

Mnemonic = The mnemonic of the parameter being interrogated

Data = 1 ASCII digit specifying the state of the parameter. This is the same digit that would be used to program the parameter to that state.

3-154. Using the Interrogate Capability.

3-155. When the 3325A is changed from local to remote operation or vice versa, it retains its currently programmed state until this program is changed by the operator or controller. This feature can be useful in setting up a program string for HP-IB programming. For example, using the 3325A in local, the operator can determine experimentally the parameters required to perform the operation or test desired. Then the 3325A can be placed in remote and its function and entry parameters interrogated. Each item can be stored by the controller and then combined to form the 3325A program string to be incorporated into the total HP-IB program.

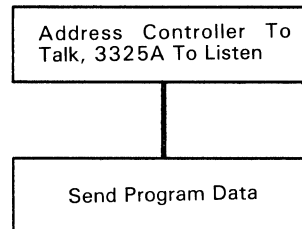
3-156. 3325A Programming Procedure.

3-157. The following examples are given to illustrate the basic procedure for developing a program. Program examples are shown in Appendix B-3, using the -hp- Model 9825A Calculator as the system controller. Appendix A-3 diagrams the required messages.

Example 1:

Address controller to talk,
3325A to listen

Send Program Data

**Example 2:**

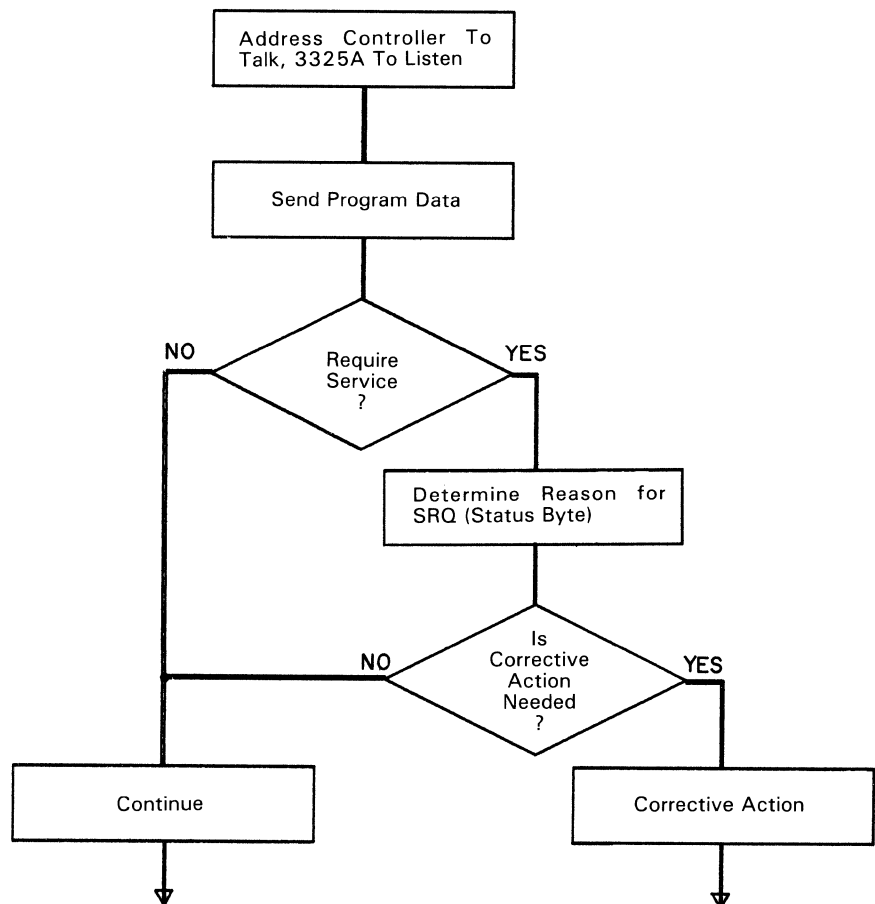
Address controller to talk,
3325A to listen

Send Program Data

Check for Require Service
message

If yes, determine reason
from 3325A Status Byte

Take corrective action if
necessary



SECTION IV

PERFORMANCE TESTS

4-1. INTRODUCTION.

4-2. This section contains tests which are in-cabinet procedures to determine whether the instrument is operating properly. In the Operating and Service Manual two sets of procedures are provided:

a. Operational Verification procedures which are recommended for incoming inspection and general after-repair tests.

b. Performance Tests which compare the instrument operation to the specifications listed in Table 1-1. The Operating Supplement contains only the Operational Verification Procedures.

4-3. CALCULATOR-CONTROLLED TEST.

4-4. The only calculator-controlled test in these procedures tests the HP-IB interface circuits for proper operation. All input and output lines are tested. The program used for this test is written specifically for the -hp- Model 9825A Calculator but may be adapted to other controllers. The calculator prints the test results. This test is recommended for both the Operational Verification Checks and the Performance Tests.

4-5. OPERATIONAL VERIFICATION.

4-6. The following procedures are recommended for incoming inspection and for testing the instrument after repair. Additional tests to be performed following repair of certain circuits are indicated in Section VIII. An Operational Verification Record is located at the end of this section. For ease of recording the test data at various times, copies of the blank Operational Verification Record may be made without written permission from Hewlett-Packard.

4-7. Operational Verification includes the following procedures:

Par. No.	Test
4-10	Self Test
4-12	Sine Wave Verification
4-14	Square Wave Verification
4-16	Triangle and Ramp Verification
4-18	Amplitude Flatness Check
4-20	Sync Output Check
4-22	Frequency Accuracy
4-24	Output Level and Attenuator Check
4-26	Harmonic Distortion Test
4-28	Close-in Spurious Signal Test
4-30	HP-IB Check

4-8. Required Test Equipment.

4-9. A list of test equipment required for the Operational Verification procedures is given in Table 4-1. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model.

4-10. Self Test.

4-11. This test uses the control, ROM, and control clock circuits to verify operation of these and other circuits. The following front panel indications result from this test.

LED check: Turns on all LED's for about two seconds

The following messages are displayed for about one second:

OSC FAIL – displayed only if the VCO is not controlled (displayed continuously after test)

PASS or FAIL 1 – tests AMPTD CAL of sine wave

PASS or FAIL 2 – tests AMPTD CAL of square wave

PASS or FAIL 3 – tests AMPTD CAL of triangle

Press the blue entry prefix key, then press SELF TEST (AMPTD CAL) key. All LED's should light, and the display should not indicate any failures.

4-12. Sine Wave Verification.

4-13. This procedure visually checks the sine wave output for the correct frequency and any visible irregularities.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load (-hp- Model 11048C 50-ohm Feed-thru Termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
 Function Sine
 Frequency 20 MHz
 Amplitude 10 V p-p

Table 4-1. Test Equipment Required for Operational Verification.

Instrument	Critical Specifications	Recommended Model
Oscilloscope	Vertical: Bandwidth: dc to 100 MHz Deflection: 1 V to 5 V/div Horizontal: Sweep: .05 μ s to 1 s/div External Sweep Input	-hp- 1740A
Electronic Counter	Frequency measurement to 20 MHz Accuracy: ± 2 counts Resolution: 8 digits	-hp- 5328A with Opt. 040 or 041
DC Digital Voltmeter	Ranges: 0.1 V to 100 V Resolution: 6 digits Accuracy: $\pm 0.1\%$	-hp- 3455A
50-ohm load	Accuracy: $\pm 0.2\%$ Power Rating: 1 W	-hp- 11048C
High Frequency Spectrum Analyzer	Frequency Range: 1 MHz to 80 MHz Amplitude Accuracy: ± 0.5 dB Noise: > 70 dB below reference	-hp- 141T/8552B/8553B
Low frequency Spectrum Analyzer	Frequency Range: 100 Hz to 50 kHz Amplitude Range: 2 mV to 20 V Noise: > 80 dB below input reference or -140 dBv	-hp- 3580A
Resistor	681 Ω , 1%, 1/2 W	-hp- 0757-0816
Adapter	BNC female-to-dual banana plug	-hp- 1250-2277
Calculator	HP-IB Control Capability	-hp- 9825A with 98034A Interface, General I/O ROM, Extended I/O ROM
Capacitor	.47 μ F	-hp- 0160-0174
Sine Wave Signal Source	Synthesizer accuracy and stability Frequency Range: 50 kHz to 200 kHz Amplitude: $+ 7$ dBm	-hp- 3335A or -hp- 3325A
Double Balanced Mixer	Impedance: 50 Ω Frequency Range: 50 kHz – 200 kHz	-hp- 10534A

c. Set the oscilloscope vertical control to 2 V/div, horizontal to .05 μ s/div.

d. The oscilloscope should display one cycle per division, approximately five divisions peak-to-peak.

e. Change 3325A frequency to 1 MHz.

f. Change oscilloscope horizontal control to .1 μ s/div.

g. The oscilloscope should display one sine wave having no visible irregularities.

High Voltage Output (Option 002)

h. Set the oscilloscope vertical control to 5 V/div.

i. Set the oscilloscope input switch to 1 M Ω dc coupled position (or disconnect external 50-ohm load).

j. Press 3325A High Voltage Output key (lower right corner of front panel).

k. Change 3325A amplitude to 40 V p-p. The oscilloscope should display one sine wave approximately eight divisions peak-to-peak having no visible irregularities.

4-14. Square Wave Verification.

4-15. This procedure checks the square wave output for frequency, rise time, and aberrations.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load (-hp- Model 11048C 50-ohm Feed-thru Termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
Function Square
Frequency 1 MHz
Amplitude 10 V p-p

c. Set the oscilloscope vertical control to 2 V/div, horizontal to .2 μ s/div. The oscilloscope should display two square waves, approximately five divisions peak-to-peak.

d. Switch the oscilloscope vertical control to 1 V/div, so that the aberrations (overshoot and ringing) can be measured. Aberration excursion should be less than 500 mV ($\frac{1}{2}$ div.).

e. Repeat Step d at 2 kHz and .1 ms/div.

f. Adjust the oscilloscope vertical and horizontal controls so that the square wave rise time between the 10% and 90% points can be measured. Rise time should be less than 20 nanoseconds.

4-16. Triangle and Ramp Verification.

4-17. This procedure checks the triangle and ramp output signals for frequency, shape, and ramp retrace time.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3324A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load (-hp- Model 11048C 50-ohm Feed-thru Termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
Function Triangle
Frequency 10 kHz
Amplitude 10 V p-p

c. Set the oscilloscope vertical control to 2 V/div, horizontal to .1 ms/div. The oscilloscope should display one triangle wave per division, approximately five divisions peak-to-peak.

d. Change 3325A function to negative slope ramp. The display should be one ramp per division, approximately five divisions peak-to-peak.

e. Change 3325A function to negative slope ramp. The display should be one ramp per division, approximately five divisions peak-to-peak.

f. Change the oscilloscope horizontal and vertical controls so that the ramp retrace time from the 90% to 10% points can be measured. Retrace time should be less than 3 μ s.

g. Change 3325A function to positive slope ramp and repeat Step f.

h. Change 3325A function to triangle.

i. Set oscilloscope vertical control to 2 V/div, horizontal to 10 μ s/div. The oscilloscope should display one triangle wave with no visible irregularities in either slope.

4-18. Amplitude Flatness Check.

4-19. This procedure provides a visual check of the sine wave amplitude flatness.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load (-hp- Model 11048C 50-ohm Feed-thru Termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
Function Sine
Frequency 2 kHz
Amplitude 10 V p-p
Sweep Start Freq 0 Hz
Sweep Stop Freq 20 MHz
Sweep Marker Freq 5 MHz
Sweep Time01 sec

c. Adjust the oscilloscope vertical selector and vernier to expand the sine wave display to the full graticule height.

d. Connect the 3325A rear panel X Drive output to the Oscilloscope External Sweep input and set the controls for external sweep.

e. Press the 3325A START CONT key.

f. The oscilloscope display should show a sweep that is essentially flat, dropping no more than 3.5% at the high end. Any D.C. variations should be ignored, taking the peak to peak reading for flatness comparison.

4-20. Sync Output Check.

4-21. This test verifies the sync output signal levels.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A sync output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load (-hp- Model 11048C 50-ohm Feedthru Termination) at the input.

b. Set the 3325A function to sine, frequency to 20 MHz.

c. Adjust the oscilloscope controls to measure the high and low voltage levels of the sine square wave. The high level should be greater than +1.2 V and the low level should be less than +0.2 V.

4-22. Frequency Accuracy.

4-23. This test compares the accuracy of the 3325A output signal to the specification in Table 1-1: $\pm 5 \times 10^{-6}$ of selected frequency.

Equipment Required: Electronic Counter (-hp- Model 5328A, calibrated within three months or with an accurate 10 MHz external reference input)

a. Connect the 3325A signal output to the electronic counter channel A input with a 50 Ω load. Allow 3325A and counter to warm up for 20 minutes.

b. Set the 3325A output as follows:

Function Sine
Frequency 20 MHz
Amplitude 0.99 V P-P
DC Offset 0 V

c. Set the counter to count the frequency of the A input with 1 Hz resolution, and adjust for stable triggering. Electronic counter should indicate 20 000 000.0 Hz $\pm$ 100 Hz.

d. Change 3325A function to square wave. Frequency automatically changes to 10 MHz. Electronic counter should indicate 10 000 000.0 Hz $\pm$ 50 Hz.

e. Change 3325A function to triangle. Frequency automatically changes to 10 kHz. Move the counter input to the sync output of the 3325A. Set the counter to average 10,000 periods. Overflow will occur, but the most significant digit may be read by switching to 1000 periods. Electronic counter should indicate 100,000 ns $\pm$.5 ns.

f. Change 3325A function to positive slope ramp. Electronic counter should indicate 100,000 ns $\pm$.5 ns.

4-24. Output Level and Attenuator Check.

4-25. This procedure checks the output level and the attenuator by using the "dc only" function.

Equipment Required:

DC Digital Voltmeter (-hp- Model 3455A)

50-ohm Feedthru Termination (-hp- Model 11048C)

a. Connect the 3325A signal output through a 50-ohm feedthru termination to a dc digital voltmeter input.

b. If the instrument has High Voltage Output Option 002, make sure the High Voltage Output is Off (High Voltage indicator light in the center of the "SIGNAL" key in the lower right corner of the front panel if Off).

c. Press whichever function key is presently active, indicated by a lighted indicator in the center of the key. This removes the ac output. The indicator in the center of the DC OFFSET key should light.

d. Set the 3325A dc offset to -5 V, then press the AMPTD CAL key.

e. the dc digital voltmeter reading should be -4.980 V to -5.020 V.

f. Change 3325A dc offset to (+)5 V. Digital voltmeter reading should be +4.980 V to +5.020 V.

g. Change 3325A dc offset to the following voltages. The voltmeter readings should be within the tolerances shown.

DC Offset	Tolerances
± 1.499 V	± 1.49300 to 1.50499 V
± 499.9 mV	± 0.49790 to 0.50190 V
± 149.9 mV	± 0.14930 to 0.15050 V
± 49.99 mV	± 0.04979 to 0.05019 V
± 14.99 mV	± 0.01493 to 0.01505 V
± 4.999 mV	± 0.004979 to 0.005019 V
± 1.499 mV	± 0.001479 to 0.001519 V

High Voltage Output Option 002 DC Offset

h. Remove the 50-ohm feedthru termination and connect the 3325A output directly to the digital voltmeter input.

i. Press the "SIGNAL" key in the lower right corner of the 3325A front panel to select High Voltage Output (Option 002). Lighted indicator in the center of this key indicates High Voltage Output is on.

j. Set 3325A dc offset to 20 V. Digital voltmeter reading should be +19.775 V to +20.225 V.

k. Set 3325A dc offset to -20 V. Digital voltmeter reading should be -19.775 V to -20.225 V.

4-26. Harmonic Distortion Test.

4-27. This procedure tests the harmonic distortion of the 3325A sine wave output against the following specifications from Table 1-1.

Harmonic Distortion (relative to fundamental)

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 50 kHz	- 65 dB
50 kHz to 200 kHz	- 60 dB
200 kHz to 2 MHz	- 40 dB
2 MHz to 15 MHz	- 30 dB
15 MHz to 20 MHz	- 25 dB

Equipment Required:

High frequency spectrum analyzer (-hp- Model 141T/8552B/8553B)

Low frequency spectrum analyzer (-hp- Model 3580A)

50-ohm feedthru termination (-hp- Model 11048C)

Resistor: 681 Ω 1% 1/2 W (-hp- Part No. 0757-0816)

Double balanced mixer (-hp- 10534A)

Sine Wave signal source (-hp- 3335A or 3325A)

Capacitor: .45 μ F (-hp- Part No. 0160-0174)

a. Set the 3325A output as follows:

High Voltage Output (Option 002) Off
 Function Sine
 Frequency 20 MHz
 Amplitude 999 Vp-p

b. Connect the 3325A signal output to the high frequency spectrum analyzer 50-ohm input (on 8553B). See Figure 4-1(a).

c. Set the Spectrum Analyzer input attenuation to 40 dB. Adjust the spectrum analyzer controls to display the fundamental frequency and at least 4 harmonics. Adjust level of fundamental to full scale on the display. All harmonics should be more than 25 dB below the fundamental.

d. Set the 3325A to the following frequencies and verify that all harmonics are below the levels required:

15 MHz	- 30 dB
2 MHz	- 40 dB
200 kHz	- 60 dB

e. Disconnect the 3325A from the high frequency spectrum analyzer and connect as shown in Figure 4-1(b).

f. Set the sine wave signal source amplitude to +7 dBm, frequency 51 kHz.

g. Set the 3325A frequency to 50 kHz, amplitude to 9.99 Vp-p.

h. If you are using the 3580A low frequency spectrum analyzer, use the following control settings:

Center Frequency	1 kHz
Resolution Bandwidth	Med
Freq Span/Div	0
Sweep Time/Div	1 sec
Sweep Mode	Rep
Amplitude Mode	10 dB Log
Amplitude Ref Level	Normal
Input Sensitivity	- 50 dBv

i. Adjust the center frequency fine tuning of the 3580A for maximum, then adjust the input sensitivity vernier for -10 dB.

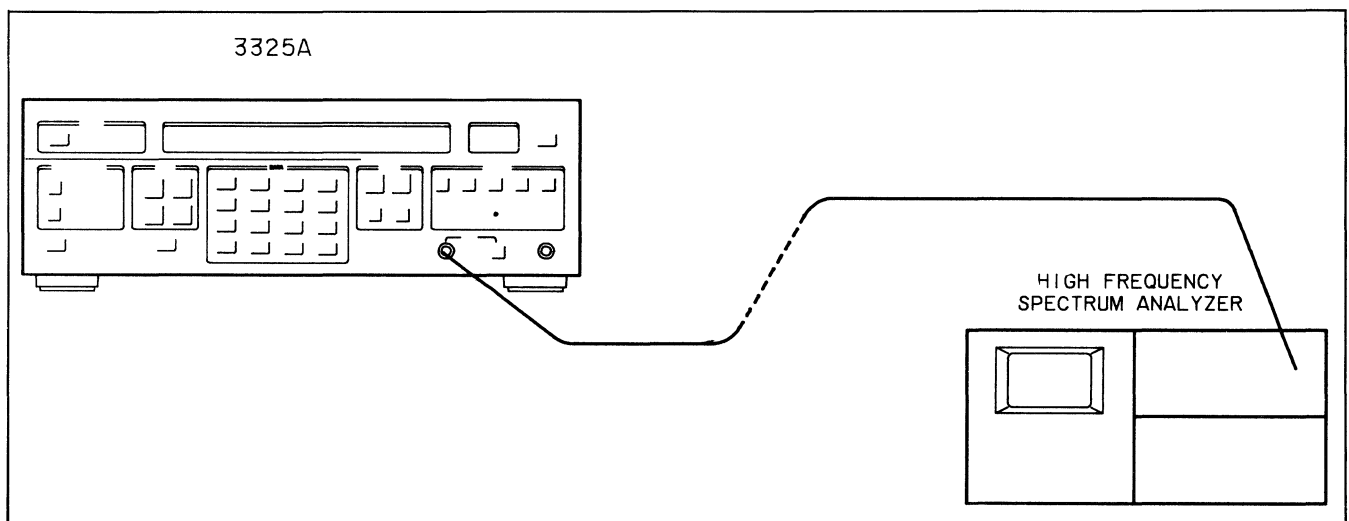


Figure 4-1(a). Harmonic Distortion Verification.

j. Change the sine wave signal source frequency to 101 kHz. Take a visual average of the 0 Hz sweep. This is the second harmonic relative to the -10 dB reference. The display reading plus 10 dB should be -65 dB or lower.

k. Change the signal source frequency to 151 kHz and read the third harmonic as in j. This completes the 50 kHz test.

l. Connect the 3325A to the low frequency spectrum analyzer as shown in Figure 4-1(a). Set the 3325A frequency to 10 kHz, amplitude to 10 Vp-p.

m. Set the low frequency spectrum analyzer as follows:

Start Frequency	0 kHz
Resolution Bandwidth	300 Hz
Display Smoothing	Med.
Freq Span/Div	5 kHz
Sweep Time/Div	1 sec
Sweep Mode	Rep
Amplitude Mode	10 dB Log
Amplitude Ref	Normal
Input Sensitivity	+10 dBv

n. The fundamental and 3 harmonics should be displayed. Adjust input sensitivity vernier to place the fundamental at 0 dB. All harmonics should be below -65 dB.

o. Change 3325A frequency to 1 kHz. Change analyzer resolution bandwidth to 100 Hz and freq span/div to .5 kHz. Verify that all harmonics are below -65 dB.

p. Change 3325A frequency to 100 Hz. Change analyzer resolution bandwidth to 10 Hz, display smoothing to min, and freq span/div to 50 Hz. Verify that all harmonics are below -65 dB.

High Voltage Output (Option 2)

q. Remove the 50 ohm feedthru termination; connect the 3325A directly to the low frequency spectrum analyzer input.

r. Set the 3325A frequency to 100 Hz, press the signal key to activate the high voltage output, and set the amplitude to 40 Vp-p.

s. Set the analyzer to display 100 Hz distortion as above. All harmonics should be below -65 dB.

t. Set the 3325A frequency to 10 kHz. Set the analyzer to display the distortion as for the standard output. All harmonics should be below -65 dB.

u. Disconnect the 3325A signal output from the low frequency spectrum analyzer, and connect it through a 681 ohm series resistor to the high frequency spectrum analyzer.

u. Disconnect the 3325A signal output from the low frequency spectrum analyzer, and connect it through a 681 ohm series resistor to the high frequency spectrum analyzer.

v. Set the 3325A frequency to 200 kHz.

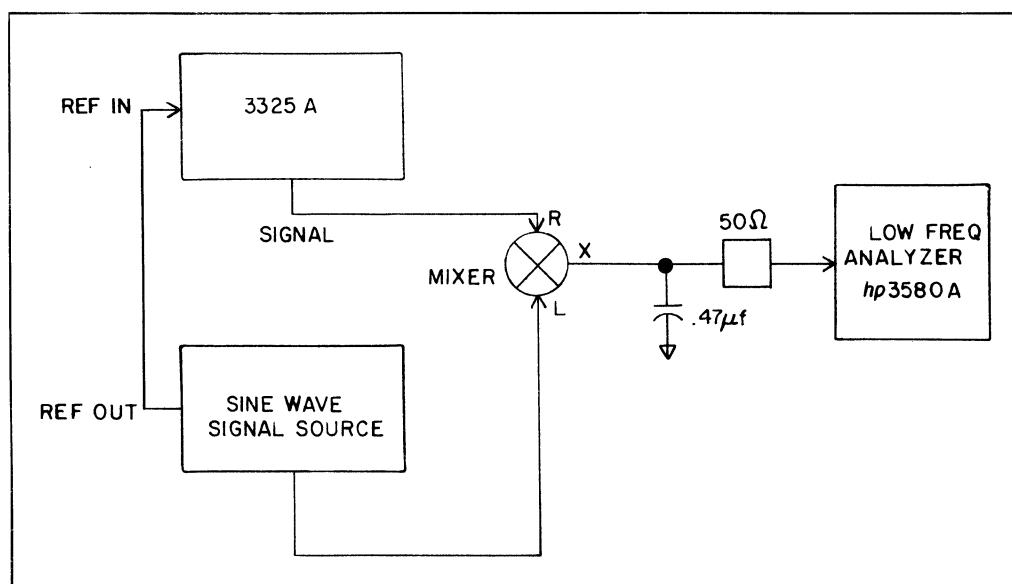


Figure 4-1(b). Harmonic Distortion Verification at 50 kHz.

x. Set the 3325A frequency to 1 MHz. Repeat Step v. All harmonics should be more than 40 dB below the fundamental.

w. Adjust the spectrum analyzer controls to observe the fundamental and at least 4 harmonics. Set the analyzer input attenuation to 50 dB. Adjust level of the fundamental to full scale on the display. All harmonics should be more than 60 dB below the fundamental.

4-28. Close-In Spurious Signal Test.

4-29. This procedure tests the sine wave output for spurious signals which may be generated by the 3325A frequency synthesis circuits. The spurious signals must be more than 70 dB lower than the fundamental signal.

Equipment Required: High frequency spectrum analyzer (-hp- 141T/8552B/8553B)

a. Set the 3325A as follows:

High Voltage Output (Option 002) Off
Function Sine
Frequency 20 MHz
Amplitude 999 mV p-p
DC Offset 0 V

b. Set the spectrum analyzer as follows:

Frequency 20 MHz
Tuning Stability Off
Bandwidth 0.01 kHz
Scan Width 0.02 kHz/div
Input Attenuator 20 dB
Base Line Clipper Fully CCW
Scan Time 0.5 sec/div
Log Ref Level 10 dBm
Linear Sens. Vernier Approx - 6 dB
Scale 10 dB Log
Video Filter 10 kHz
Scan Mode Manual
Scan Trigger Auto

c. Connect the 3325A signal output to the spectrum analyzer input (50 ohm).

d. Adjust spectrum analyzer scan control to place the marker dot on the vertical center line of the display.

e. Carefully adjust spectrum analyzer frequency control to place the 3325A output signal at the marker (indicated by a sharp vertical deflection of the dot). This adjustment does not have to be exact but should be very close.

f. Set spectrum analyzer tuning stabilizer to ON. Using the frequency vernier control, adjust carefully for maximum vertical deflection of the marker dot. This should be very near the top line of the display.

g. Set the spectrum analyzer Scan Mode to INT.

h. Adjust spectrum analyzer Linear Sensitivity Vernier to set signal reference level to 0 dB (full scale).

i. Set 3325A frequency to 20 001 000.0 Hz. (This may be done either by entering this frequency or by using the Modify keys.)

j. If a spurious signal is present, it will appear at the same horizontal position that the signal appeared (Step h). All spurious signals should be more than 70 dB below the reference.

4-30. HP-IB Interface Test.

4-31. The following calculator program tests the operation of the 3325A HP-IB interface circuits. The program is written for an -hp- Model 9825A calculator but may be adapted for other controllers.

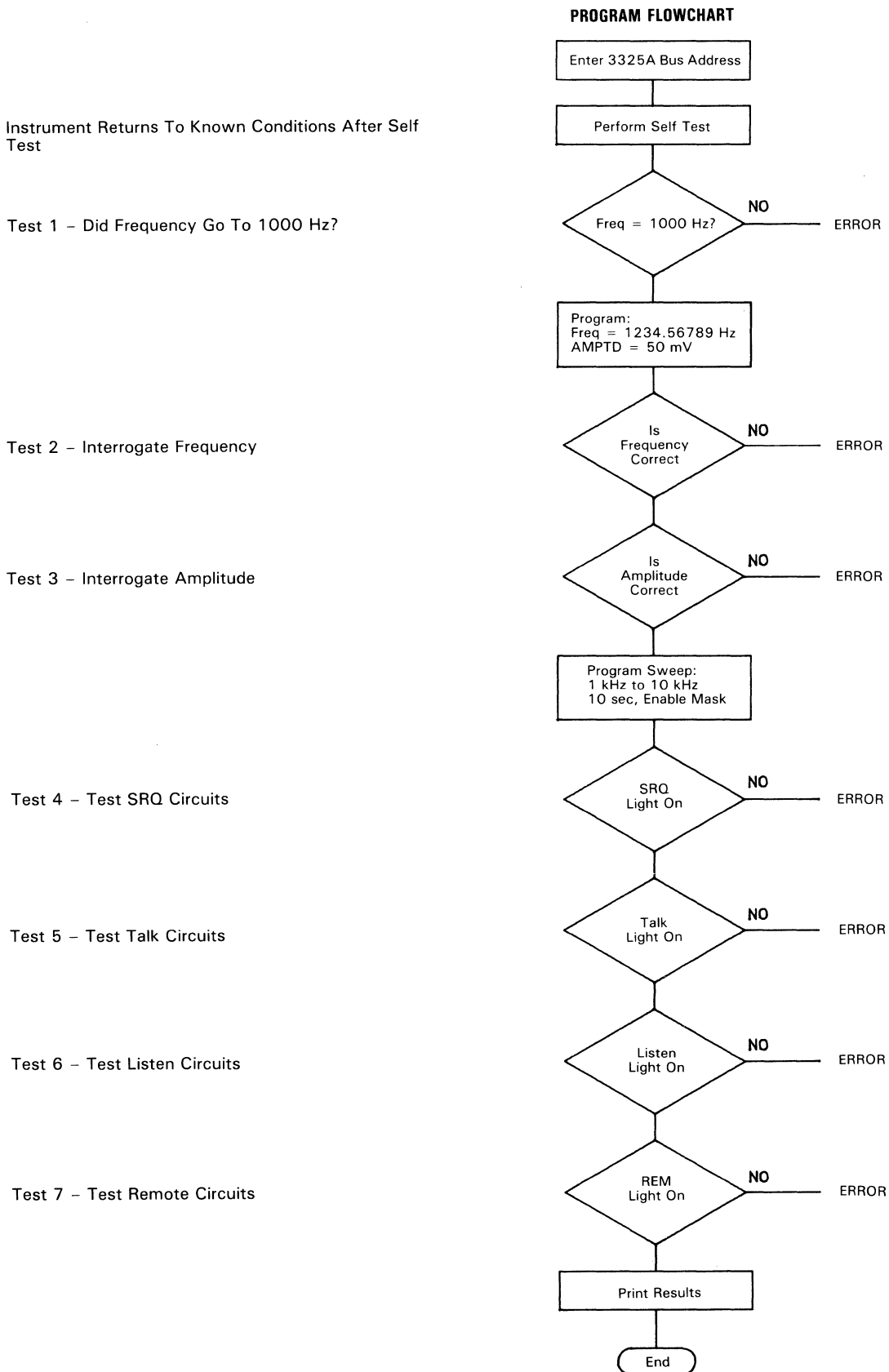
Equipment Required:

-hp- Model 9825A Calculator equipped with:
98034A HP-IB Interface (set to select code 7)
Any combination of ROM's that includes a General I/O ROM and an Extended I/O ROM

a. Connect the calculator interface cable to the 3325A rear panel HP-IB connector. It is recommended that no other equipment be connected to this HP-IB during this test.

b. Enter the program into the calculator.

c. Press RUN. Tests 4 through 7 in this program require the operator to press CONTINUE if the test passes, or 1 CONTINUE if the test fails. If the Test 4 question (SRQ LIGHT ON?, 1 = NO) does not appear in the calculator display within 30 seconds after start of the program (RUN), the 3325A and calculator are not interfacing properly. The calculator may display an error indication that will identify the problem. If not, the 3325A HP-IB circuits are probably not operating correctly.



```

0: fnt i:csvi0+r1+r2+r3+r4+r5+r6+r7
1: prt "*****"
2: prt "3325A"
3: prt "HP-IB TEST"
4: prt "*****"
5: beepient "3325A BUS ADDRESS?,cont=717",A'
6: if f1=13;717+A
7: clr A _____ Clear the 3325A to Turn-on State
8: rem 7 _____ Set HP-IB Remote Enable (Select Code 7)
9:
10: "TEST 1":
11: wrt A,"TE" _____ Perform Self Test
12: wrt A,"IFR" _____ Interrogate Frequency
13: red A,F _____ Read 3325A Frequency
14: if F#1000;1+r1 _____ Compare Frequency to 1000 Hz
15:
16: "TEST 2,3 SETUP":
17: wrt A,"FR1234.567890HZ AM50MV" _____ Set Freq to 1234.567890 Hz, Amptd to 50mV
18: wrt A,"SR3" _____ Store Settings in Register 3
19: clr A _____ Clear the 3325A
20: wrt A,"RE3" _____ Recall Settings in Register 3
21:
22: "TEST 2":
23: wrt A,"IFR" _____ Interrogate Frequency
24: red A,G _____ Read Frequency
25: if G#1234.56789;1+r2 _____ Compare to Frequency Stored
26:
27: "TEST3":
28: wrt A,"IAM" _____ Interrogate Amplitude
29: red A,H _____ Read Amplitude
30: if H#.05;1+r3 _____ Compare to Amplitude Stored
31:
32: "TEST 4":
33: wrt A,"ST1KH SP10KH SM1 TI10SE MSF SSSS"Lin Sweep 1—10kHz, Enable SRQ Mask
34: cli 7;lcl 7 _____ Clear Interface, Interface to Local
35: beepient "SRQ LIGHT ON?,1=NO",r4 _____ Did 3325A Initiate SRQ?
36:
37: "TEST 5":
38: rds(A)+S _____ Read Status into Variable 5
39: rem 7 _____ Set Remote Enable
40: red A,S _____ Read from the 3325A
41: beepient "TALK LIGHT ON?,1=NO",r5 _____ Did 3325A respond to Talk Command?
42:
43: "TEST6":
44: wrt A;lcl 7 _____ Write to the 3325A, Interface to Local
45: beepient "LISTEN LIGHT ON?,1=NO",r6 _____ Did 3325A respond to Listen Command?
46:
47: "TEST 7":
48: rem 7;wrt A;cli 7 _____ Remote Interface, Write to 3325A, Clear Interface
49: beepient "REMOTE LIGHT ON?,1=NO",r7 _____ Did the 3325A Respond to Remote?
50:

```



```

51: spc iprt "*****"
52: prt "TEST RESULTS:"
53: spc i1+I;fxd 0
54: if rI=0;prt "TEST",I,"      PASS"
55: if rI=1;prt "TEST",I,"      FAIL"
56: if (I+1+I)<=7;jmp -2
57: prt "*****";spc 3
58: ent "Repeat test?,1=Yes",C;if C=1;eto 0
59: end
*24386

```

Print Results of Tests

Self Contained Program may be Linked or Used as a Subroutine

Variables used in this Test Program:

A Address of 3325A (defaults to 717)
 F Frequency read from 3325A in test #1
 G Frequency read from 3325A in test #2
 H Amplitude read from 3325A in test #3
 I Counter used to print test results
 r1-r7 Test results (0 = Pass, 1 = Fail)
 S Status read from 3325A in test #5

Samples of Program Printouts:

```

*****
3325A
HP-IB TEST
*****

```

```

*****
TEST RESULTS:

TEST          1
PASS
TEST          2
PASS
TEST          3
PASS
TEST          4
FAIL
TEST          5
PASS
TEST          6
PASS
TEST          7
PASS
*****

```

```

*****
3325A
HP-IB TEST
*****

```

```

*****
TEST RESULTS:

TEST          1
PASS
TEST          2
PASS
TEST          3
PASS
TEST          4
PASS
TEST          5
PASS
TEST          6
PASS
TEST          7
PASS
*****

```

4-32. PERFORMANCE TESTS.

4-33. The following procedures compare the instrument operation to its specifications, listed in Table 1-1. A Performance Test Record is located at the end of this section. This Test Record lists all of the tested specifications and the acceptable limits. For ease of recording data at various times, copies of the blank Performance Test Record may be made without written permission from Hewlett-Packard.

4-34. The Performance Tests include the following:

Par No.	Test
4-37	Harmonic Distortion
4-39	Spurious Signal Tests
4-41	Integrated Phase Noise

4-43	Amplitude Modulation Envelope Distortion
4-45	Square Wave Rise Time and Aberrations
4-47	Ramp Retrace Time
4-49	Sync Output
4-51	Square Wave Symmetry
4-53	Frequency Accuracy
4-55	Phase Increment Accuracy
4-47	Phase Modulation Linearity
4-59	Amplitude Accuracy
4-61	DC Offset Accuracy (DC Only)
4-63	DC Offset Accuracy with AC Functions
4-65	Triangle Linearity
4-67	X Drive Linearity
4-69	Ramp Period Variation
4-71	HP-IB Interface

Table 4-2. Test Equipment Required For Performance Tests.

Instrument	Critical Specifications	Recommended Model
High Frequency Spectrum Analyzer	Frequency Range: 1 kHz to 80 MHz Amplitude Accuracy: ± 0.5 dB Noise: > 70 dB below reference	-hp- 141T/8552B/8553B
50-ohm Load	Accuracy: $\pm 0.2\%$ Power Rating: 1 W	-hp- Model 11048C
Resistor	681 Ω 1% 1/2 W	-hp- 0757-0816
Low Frequency Spectrum Analyzer	Frequency Range: 5Hz to 50 kHz Amplitude Accuracy: ± 0.5 dB Spurious Responses: 80 dB below reference	-hp- 3580A
Sine Wave Signal Source	Frequency Range: 1 MHz to 21 MHz Amplitude Range: to + 13.01 dBm Output Impedance: 50 Ω Phase Noise (Integrated): 9.9 MHz: < -63 dB 20 MHz: < -70 dB Spurious: > 75 dB below fundamental	-hp- 3335A
Double Balanced Mixer	Impedance: 50 Ω Frequency Range: 1 MHz-20 MHz	-hp- 10534A
AC/DC Digital Voltmeter	AC function (True RMS) Ranges: 1 V to 100 V Accuracy: $\pm 0.2\%$ Resolution: 6 digits Crest Factor: 4:1 DC Function Ranges: 0.1 V to 100 V Accuracy: $\pm 0.05\%$ Resolution: 6 digits	-hp- 3455A
1 MHz Low Pass Filter	Cut-off Frequency: 1 MHz Stopband Atten: 50 dB by 4 MHz Stopband Freq: 4 MHz-80 MHz	J903 TT Electronics, Inc. 2214 S. Barry Ave. Los Angeles, CA 90064
15 kHz Filter	Consisting of: Resistor: 10 k Ω 1% Capacitor: 1600 pF 5%	-hp- 0757-0340 -hp- 0160-2223
Capacitor	.47 μ F Ceramic	-hp- 0160-0174
AC Voltmeter	Ranges: 0.1 V to 1 V Frequency Range: 21 Hz-1 MHz Input Impedance: ≥ 1 M Ω Meter: Log scale Acc (100 Hz to 10 kHz): $\pm 1\%$	-hp- 400FL
Sine Wave Signal Source	Frequency: 10 kHz Amplitude: 1 V rms into 20 k Ω Distortion: -60 dB	-hp- 204C

Table 4-2. Test Equipment Required For Performance Tests (Cont'd).

Instrument	Critical Specifications	Recommended Model
Oscilloscope	Vertical: Bandwidth: dc to 100 MHz Deflection: 1 V to 5 V/div Horizontal: Sweep: 0.05 μ s to 1 s/div x 10 magnification	-hp- 1740A
Electronic Counter	Frequency measurement Frequency Range: to 20 MHz Resolution: 8 digits Accuracy: $\pm$ 2 counts Time Interval Average A to B Resolution: 0.01 ns	-hp- 5328A With Option 040 or 041
DC Power Supply	Volts: 0 to $\pm$ 5 V Amps: 10 mA Floating Output	-hp- 6214A
Thermal Converter	Input Impedance: 50 Ω Input Voltage: 1 V rms Frequency: 2 kHz to 20 MHz Frequency Response: $\pm$ 0.05 dB 2 kHz to 20 MHz	-hp- 11050A
Resistive Divider	Consisting of: 2 Resistors: 61.11 Ω .1% 1/4 W 2 Resistors: 36.55 Ω .1% 1/8 W	-hp- 0699-0090 -hp- 0698-7169
Resistive Divider	Capacitor: 300 pF 5% Consisting of: 3 Resistors: 1330 Ω .1% 1/4 W Resistor: 43 Ω .1% 1/8 W	-hp- 0160-2207 -hp- 0698-7453 -hp- 0698-8264
High-Speed DC Digital Voltmeter	DC Voltage: 0 to $\pm$ 10 V External Trigger: Low True TTL Edge Trigger Trigger Delay: Selectable 10 μ s to 140 μ s	-hp- 3437A
BNC-to-Triax Adapter	50 ohm	-hp- 1250-0595 Adapter or 11172A RF Cable
Resistive Divider $\div$ 2.5	Consisting of: Resistor: 30 Ω 1% 1/4 W Resistor: 20 Ω 1% 1/4 W	-hp- 0698-7533 -hp- 0698-6296
Resistive Divider $\div$ 2.6	Consisting of: Resistor: 100 k Ω 1% 1/8 W Resistor: 162 k Ω 1% 1/8 W	-hp- 0757-0465 -hp- 0757-0470
Calculator	HP-IB Control Capability	-hp- 9825A with 98034A Interface, General I/O ROM, Extended I/O ROM
Adapter	Female BNC-to-Dual Banana Plug BNC Tee	-hp- 1250-2277 -hp- 1250-0781

4-35. Equipment Required.

4-36. The test equipment required for the Performance Tests is listed in Table 4-2. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model.

4-37. Harmonic Distortion Test.

4-38. This procedure tests the harmonic distortion of the 3325A sine wave output against the following specifications from Table 1-1.

Harmonic Distortion (relative to fundamental)

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 50 kHz	– 65 dB
50 kHz to 200 kHz	– 60 dB
200 kHz to 2 MHz	– 40 dB
2 MHz to 15 MHz	– 30 dB
15 MHz to 20 MHz	– 25 dB

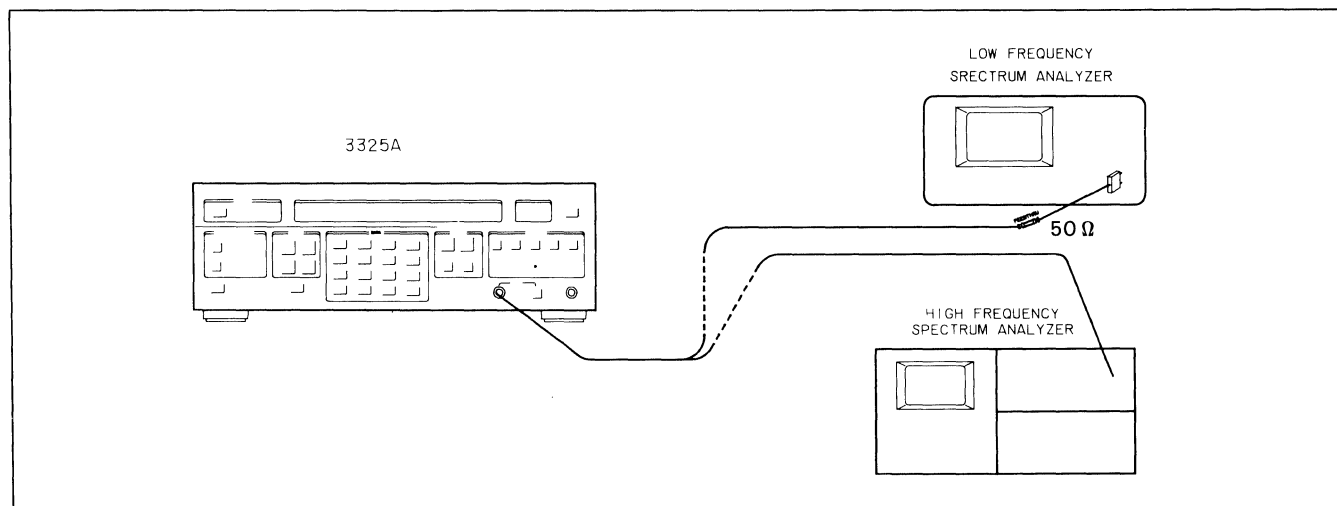


Figure 4-2(a). Harmonic Distortion Test.

Equipment Required:

High frequency spectrum analyzer (-hp- Model 141T/8552B/8553B)
 Low frequency spectrum analyzer (-hp- Model 3580A)
 50-ohm feedthru termination (-hp- Model 11048C)
 Resistor: 681 Ω 1% 1/2 W (-hp- Part No. 0757-0816)
 Double Balanced Mixer (-hp- 10534A)
 Sine Wave Signal Source (-hp- 3335A or 3325A)
 Capacitor: .47 μ F (-hp- Part No. 0160-0174)

a. Set the 3325A output as follows:

High Voltage Output (Option 002) Off
 Function Sine
 Frequency 20 MHz
 Amplitude 999 Vp-p

b. Connect the 3325A signal output to the high frequency spectrum analyzer 50-ohm input (on 8553B). See Figure 4-2(a).

c. Set the Spectrum Analyzers input attenuation to 40 dB. Adjust the spectrum analyzer controls to display the fundamental frequency and at least 4 harmonics. Adjust level of fundamental to full scale on the display. All harmonics should be more than 25 dB below the fundamental.

d. Set the 3325A to the following frequencies and verify that all harmonics are below the levels required:

15 MHz	- 30 dB
2 MHz	- 40 dB
200 kHz	- 60 dB

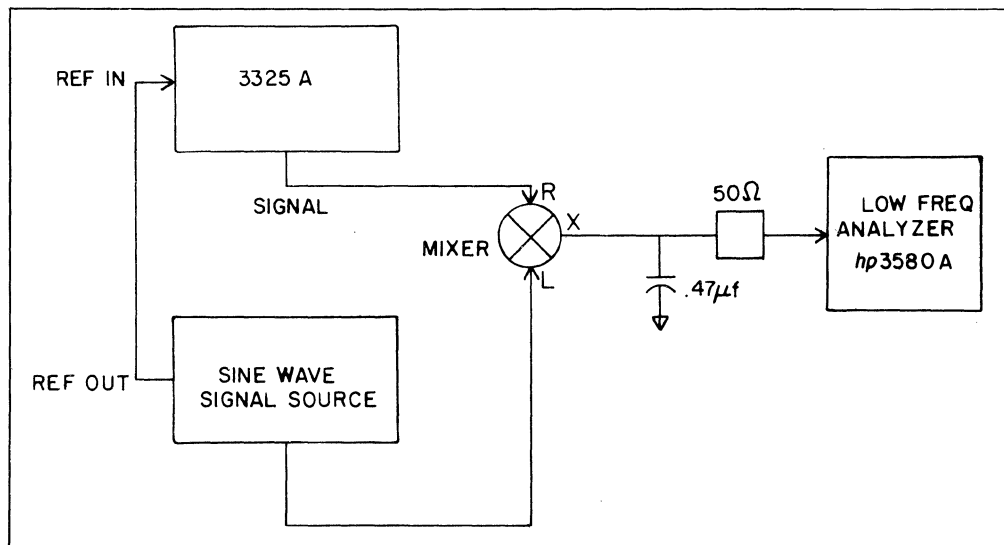


Figure 4-2(b). Harmonic Distortion Test at 50 kHz.

e. Disconnect the 3325A from the high frequency spectrum analyzer and connect as shown in Figure 4-2(b).

f. Set the sine wave signal source amplitude to +7 dBm, frequency 51 kHz.

g. Set the 3325A frequency to 50 kHz, amplitude to 9.99 Vp-p.

h. If you are using the 3580A low frequency spectrum analyzer, use the following control settings:

Center Frequency	1 kHz
Resolution Bandwidth	Med
Freq Span/Div	0
Sweep Time/Div	1 sec
Sweep Mode	Rep
Amplitude Mode	10 dB Log
Amplitude Ref Level	Normal
Input Sensitivity	-50 dBv

i. Adjust the center frequency fine tuning of the 3580A for maximum, then adjust the input sensitivity vernier for -10 dB.

j. Change the sine wave signal source frequency to 101 kHz. Take a visual average of the 0 Hz sweep. This is the second harmonic relative to the -10 dB reference. The display reading plus 10 dB should be -65 dB or lower.

k. Change the signal source frequency to 151 kHz and read the third harmonic as in j. This completes the 50 kHz test.

l. Connect the 3325A to the low frequency spectrum analyzer as shown in Figure 4-2(a). Set the 3325A frequency to 10 kHz, amplitude to 10 Vp-p.

m. Set the low frequency spectrum analyzer as follows:

Start Frequency	0 kHz
Resolution Bandwidth	300 Hz
Display Smoothing	Med.
Freq Span/Div	5 kHz
Sweep Time/Div	1 sec
Sweep Mode	Rep
Amplitude Mode	10 dB Log
Amplitude Ref	Normal
Input Sensitivity	+10 dBv

n. The fundamental and 3 harmonics should be displayed. Adjust input sensitivity vernier to place the fundamental at 0 dB. All harmonics should be below -65 dB.

o. Change 3325A frequency to 1 kHz. Change analyzer resolution bandwidth to 100 Hz and freq span/div to .5 kHz. Verify that all harmonics are below -65 dB.

p. Change 3325A frequency to 100 Hz. Change analyzer resolution bandwidth to 10 Hz, display smoothing to min, and freq span/div to 50 Hz. Verify that all harmonics are below -65 dB.

High Voltage Output (Option 2)

q. Remove the 50 ohm feedthru termination; connect the 3325A directly to the low frequency spectrum analyzer input.

r. Set the 3325A frequency to 100 Hz, press the signal key to activate the high voltage output, and set the amplitude to 40 Vp-p.

s. Set the analyzer to display 100 Hz distortion as above. All harmonics should be below -65 dB.

t. Set the 3325A frequency to 10 kHz. Set the analyzer to display the distortion as for the standard output. All harmonics should be below -65 dB.

u. Disconnect the 3325A signal output from the low frequency spectrum analyzer, and connect it through a 681 ohm series resistor to the high frequency spectrum analyzer.

v. Set the 3325A frequency to 200 kHz.

w. Adjust the spectrum analyzer controls to observe the fundamental and at least 4 harmonics. Set the analyzer input attenuation to 50 dB. Adjust level of the fundamental to full scale on the display. All harmonics should be more than 60 dB below the fundamental.

x. Set the 3325A frequency to 1 MHz. Repeat Step v. All harmonics should be more than 40 dB below the fundamental.

4-39. Spurious Signal Tests.

4-40. This procedure tests the 3325A sine wave output for spurious signals. Circuits within the 3325A may generate repetitive frequencies that are not harmonically related to the fundamental output frequency. All spurious signals must be more than 70 dB below the fundamental signal or less than -90 dBm, whichever is greater.

Equipment Required:

High frequency spectrum analyzer (-hp- Model 141T/8552B/8553B)

Low frequency spectrum analyzer (-hp- Model 3580A)

Sine wave signal source (-hp- Model 3335A)

Mixer (-hp- Model 10534A)

50-ohm feedthru terminal (-hp- Model 11048C)

Mixer Spurious Test

a. Connect the 3325A signal output to the high frequency spectrum analyzer 50-ohm input as shown in Figure 4-3(a).

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
 Function Sine
 Amplitude -20 dBm
 DC Offset 0 V
 Sweep Start Frequency 10 MHz
 Sweep Stop Frequency 20 MHz
 Marker Frequency 5 MHz
 Sweep Time 5 sec

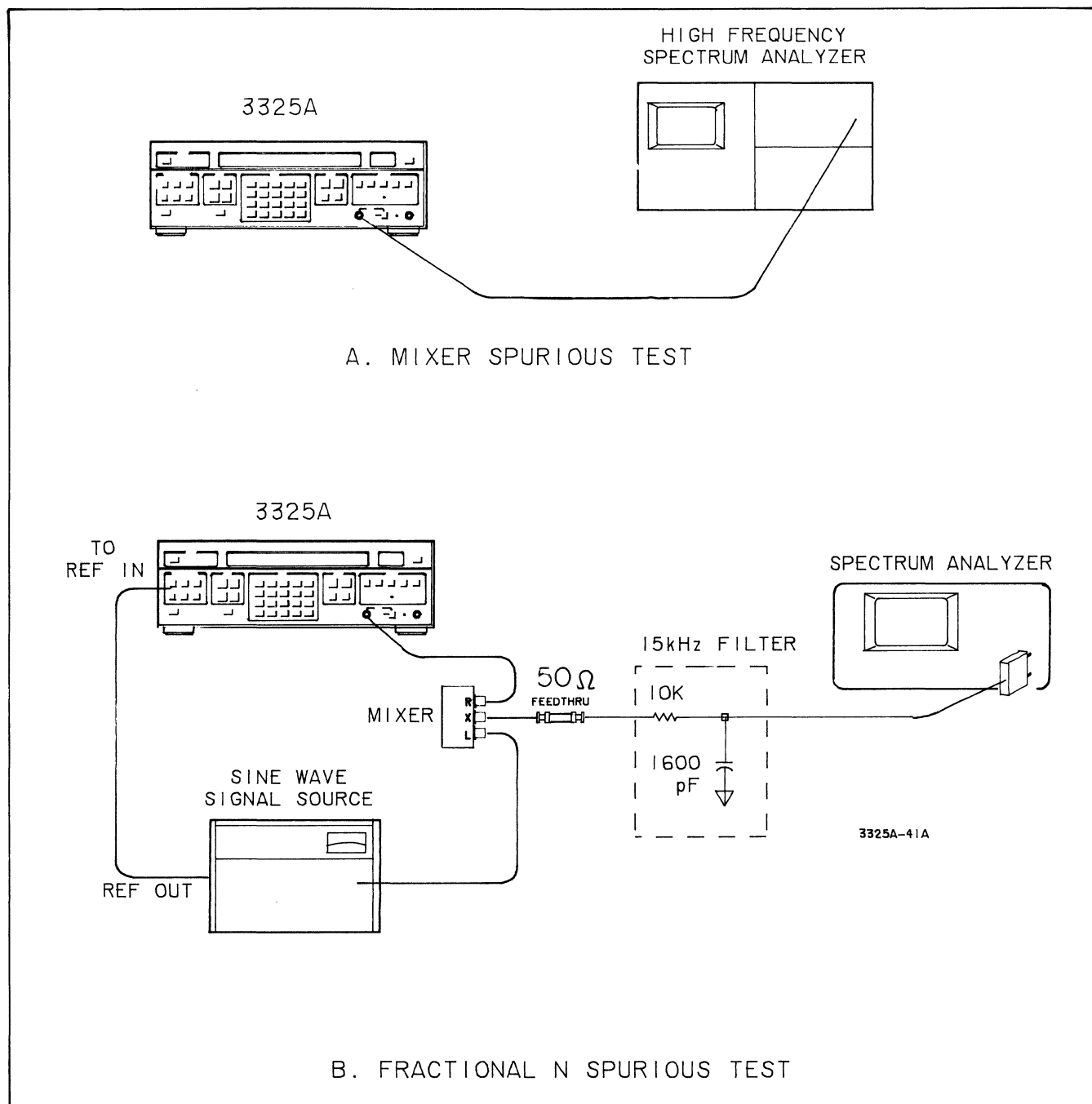


Figure 4-3. Spurious Tests.

c. Press "START CONT" key.

d. Adjust the spectrum analyzer to display the fundamental frequencies and the 2:1 spur which will sweep between 10 MHz and 20 MHz. (As the fundamental frequency sweeps from 10 MHz to 20 MHz, the spur will sweep from 20 MHz to 10 MHz.) Suggested control settings for the -hp- Model 141T/8552B/8553B are as follows:

Frequency 15 MHz
 Bandwidth 30 kHz
 Scan Width 1 MHz/div
 Attenuator 10 dB
 Base Line Clipper CCW
 Scan Time 20 ms/div
 Log Ref Level 0 dB
 10 dB Log Sensitivity -10
 Video Filter 10 kHz

e. The 2:1 spur should be more than 70 dB below the level of the fundamental.

Close-in Spurios Test

f. Connect the equipment as shown in Figure 4-3(b).

g. Set 3325A frequency to 5 MHz, amplitude to 0 dBm.

h. Set the sine wave signal source frequency to 5.01 MHz, amplitude to +7.00 dBm.

i. Adjust the spectrum analyzer to display to 10 kHz difference frequency (from the mixer and low pass filter) and set the reference level.

j. Change the 3325A frequency to 5.001 MHz.

k. All spurious (non-harmonic) signals should be 70 dB lower than the reference set in Step i.

l. Repeat Steps g through k for frequencies of 10.010 MHz, 15.010 MHz, and 20.010 MHz.

m. All spurious (non-harmonic) signals should be 70 dB lower than the reference set in Step i.

n. Repeat Steps g through m for frequencies of 10.001 MHz, 15.001 MHz, and 20.001 MHz.

4-41. Integrated Phase Noise Test.

4-42. This test compares the integrated phase noise to the specification in Table 1-1, which is:

-60 dB for a 30 kHz band centered on a 20 MHz carrier (excluding ± 1 Hz about the carrier).

Equipment Required:

Sine wave signal source (-hp- Model 335A)

Mixer (-hp- Model 10534A)

50-ohm load (-hp- Model 11048C)

DC digital voltmeter (-hp- Model 3455A)

AC voltmeter (-hp- Model 400 FL)

15 kHz noise equivalent filter consisting of:

Resistor: $10\text{ k}\Omega \pm 1\%$ (-hp- Part No. 0757-0340)

Capacitor: $1600\text{ pF} \pm 5\%$ (-hp- Part No.

0160-2223) See Figure 4-4

a. Connect the equipment as shown in figure 4-4, connecting the 15 kHz noise equivalent filter output to the ac voltmeter. Phase lock the 3325A and the signal generator together.

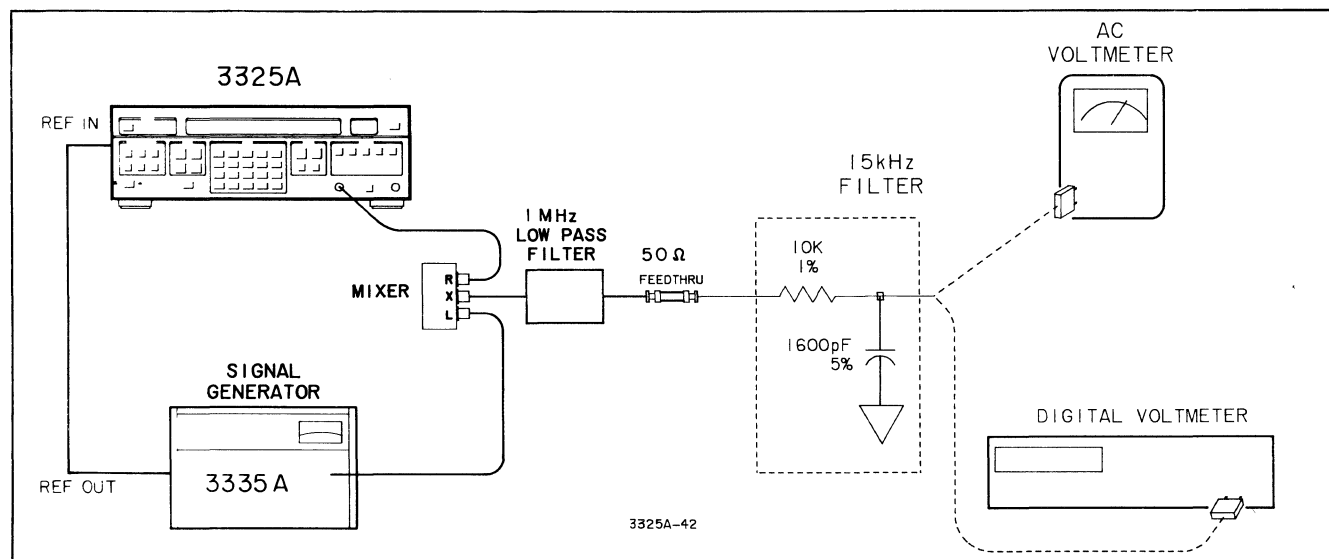


Figure 4-4. Integrated Phase Noise Test.

- b. Set the 3325A as follows:

FunctionSine
 Frequency19.901 MHz
 Amplitude0 dBm

- c. Set the sine wave signal source (reference) as follows:

Frequency19.9 MHz
 Amplitude+7.00 dBm

- d. Record the ac voltmeter reading (dB scale).

- e. Change 3325A frequency to 19.9 MHz.

- f. Connect the 15 kHz filter output to the dc digital voltmeter.

- g. Press the 3325A PHASE entry key. Using the MODIFY keys, adjust the 3325A output phase for a minimum reading on the digital voltmeter.

- h. Disconnect the 15 kHz filter output from the digital voltmeter and connect it to the ac voltmeter.

- i. Record the ac voltmeter reading (dB scale) and subtract it from the reading recorded in Step d. The difference should be -54 dB or greater. Add -6 dB to this number and enter on the performance test card. The 6 dB is a correction factor compensating for the folding action of the mixer.

NOTE

Frequencies used minimize the phase noise contribution of the 3325A.

4-43. Amplitude Modulation Envelope Distortion Test.

4-44. This procedure tests the 3325A against the amplitude modulation envelope distortion specification in Table 1-1:

-30 dB to 80% modulation at 10 kHz, 0 V dc offset

Equipment Required:

Sine wave signal source (-hp- Model 204C)
 Spectrum analyzer (-hp- Model 141T/8552B/8553B)

- a. Connect the equipment as shown in Figure 4-5.

- b. Set the 3325A output as follows:

FunctionSine
 Frequency1 MHz
 Amplitude3 Vp-p
 DC Offset0 V
 High Voltage Output (Option 002)Off
 AMOn

- c. Set the modulating signal source frequency to 10 kHz and adjust the level to produce 80% modulation of the 3325A output. 80% modulation is indicated by modulation sidebands being 8.0 dB down from the carrier, as viewed on the 2 dB/div display of the spectrum analyzer.

- d. Adjust the spectrum analyzer to display the fundamental frequency, the 10 kHz sideband frequency, and at least 4 harmonics of the sidebands. All harmonics should be at least 30 dB lower than the modulation sidebands.

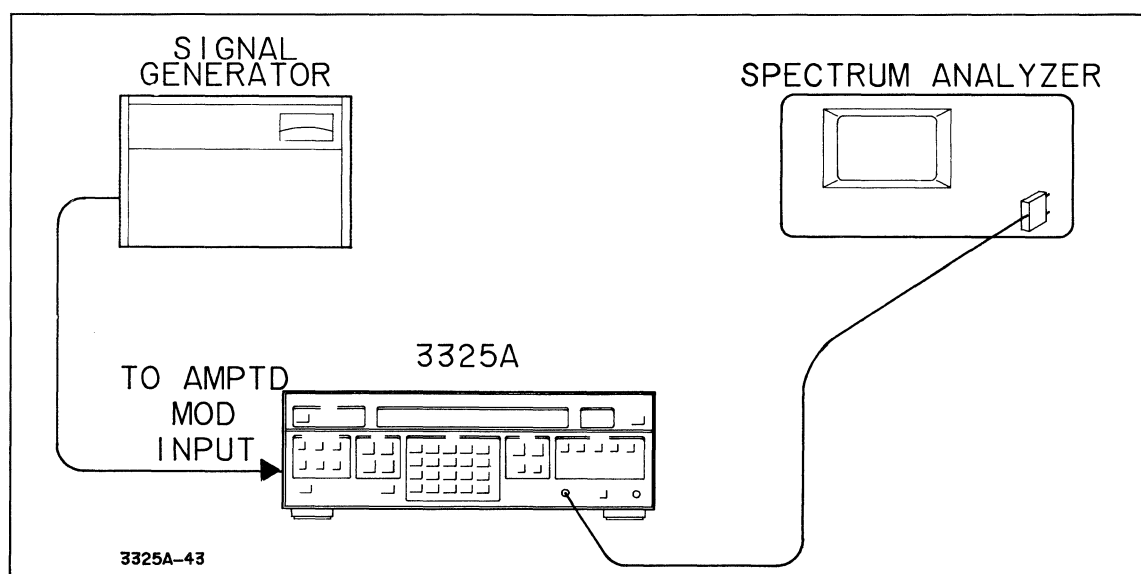


Figure 4-5. AM Envelope Distortion

4-45. Square Wave Rise Time and Abberations.

4-46. This procedure compares the 3325A square wave output to its rise/fall time and overshoot specifications in Table 1-1.

Rise and Fall Time: <20 ns, 10% to 90% at full output

Overshoot: <5% of p-p amplitude at full output

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load (-hp- Model 11048C 50-ohm feedthru termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
Function Square
Frequency 1 MHz
Amplitude 10 V p-p

c. Adjust the oscilloscope vertical and horizontal controls so that the square wave rise time between the 10% and 90% points can be measured. Rise time should be less than 20 nanoseconds.

d. Adjust the oscilloscope to measure the square wave fall time between the 90% and 10% points. Fall time should be less than 20 nanoseconds.

e. Expand the oscilloscope vertical display and adjust controls so that the overshoot can be measured. Overshoot should be less than 500 mV at positive and negative peaks.

4-47. Ramp Retrace Time.

4-48. This test compares the retrace time of the positive and negative slope ramps to the specifications in Table 1-1:

<3 μ s 90% to 10%

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load (-hp- Model 11048C 50-ohm feedthru termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
Function Positive Slope Ramp
Frequency 10 kHz
Amplitude 10 V p-p

c. Adjust the oscilloscope vertical and horizontal controls so that the ramp retrace time from the 90% to 10% points can be measured. Retrace time should be less than 3 μ s.

d. Change function to negative slope ramp and repeat Step c.

4-49. Sync Output Test.

4-50. This procedure checks the voltage levels of the sync output square wave:

$V_{\text{high}} > +1.2\text{V}; V_{\text{low}} > +0.2\text{ V}$ into 50 ohms

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A sync output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load at the input (-hp- Model 11048C 50-ohm Feedthru Termination).

b. Set the 3325A function to sine, frequency to 20 MHz.

c. Adjust the oscilloscope controls to measure the high and low levels of the sync square wave. The high level should be greater than +1.2 V and the low level should be less than +0.2 V.

4-51. Square Wave Symmetry.

4-52. This procedure checks the symmetry of the square wave signal output to the specification in Table 1-1:

0.02% of period + 3 nanoseconds

Equipment Required: Electronic counter (-hp- Model 5328A)

a. Connect the 3325A signal output to both inputs of the electronic counter, using a BNC tee (see Figure 4-6).

b. Set the 3325A output as follows:

Function Square
Frequency 1 MHz
Amplitude 1 V rms
DC Offset 0 V

c. Adjust the electronic counter to measure time interval average A to B, with Slope A +, Slope B -. Note the reading.

d. Change Slope A to -, Slope B to +. Reading should be equal to the reading in Step c $\pm$ < 3.2 ns.

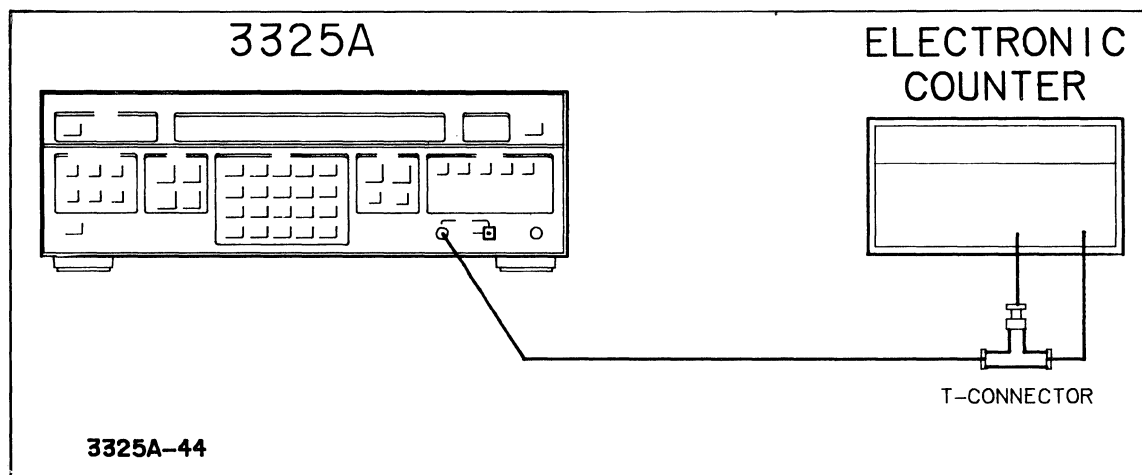


Figure 4-6. Square Wave Symmetry.

4-53. Frequency Accuracy.

4-54. This test compares the accuracy of the 3325A output signal to the specification in Table 1-1:

$$\pm 5 \times 10^{-6} \text{ of selected frequency}$$

Equipment Required: Electronic Counter (-hp- Model 5328A, calibrated within three months or with an accurate 10 MHz external reference input)

a. Connect the 3325A signal output to the electronic counter channel A input with a 50 Ω load. Allow 3325A and counter to warm up for 20 minutes.

b. Set the 3325A output as follows:

Function	Sine
Frequency	20 MHz
Amplitude	0.99 V P-P
DC Offset	0 V

c. Set the counter to count the frequency of the A input with 1 Hz resolution, and adjust for stable triggering. Electronic counter should indicate 20 000 000.0 Hz $\pm$ 100 Hz.

d. Change 3325A function to square wave. Frequency automatically changes to 10 MHz. Electronic counter should indicate 10 000 000.0 Hz $\pm$ 50 Hz.

e. Change 3325A function to triangle. Frequency automatically changes to 10 kHz. Move the counter input to the sync output of the 3325A. Set the counter to average 10,000 periods. Overflow will occur, but the most significant digit may be read by switching to 1000 periods. Electronic counter should indicate 100,000 ns $\pm$.5 ns.

f. Change 3325A function to positive slope ramp. Electronic counter should indicate 100,000 ns $\pm$.5 ns.

4-55. Phase Increment Accuracy.

4-56. This test compares the phase increment accuracy of the 3325A to the specification in Table 1-1:

$$\pm 0.2^\circ$$

Equipment Required:

Sine wave signal source (-hp- Model 3335A)
Electronic Counter (-hp- Model 5328A)

a. Connect the equipment as shown in Figure 4-8.

b. Set the 3325A as follows:

High Voltage Output (Option 002)	Off
Function	Sine
Frequency	100 kHz
Amplitude	13 dBm

c. Set the sine wave signal source (3335A) as follows:

Frequency	0.1 MHz
Amplitude	13 dBm

d. Set the electronic counter (5328A) as follows:

Function	Time Interval Avg. A to B
Frequency Resolution, N	10^5
Inputs	50 Ω , Separate
Slope A and B	Positive
Sample Rate	Maximum

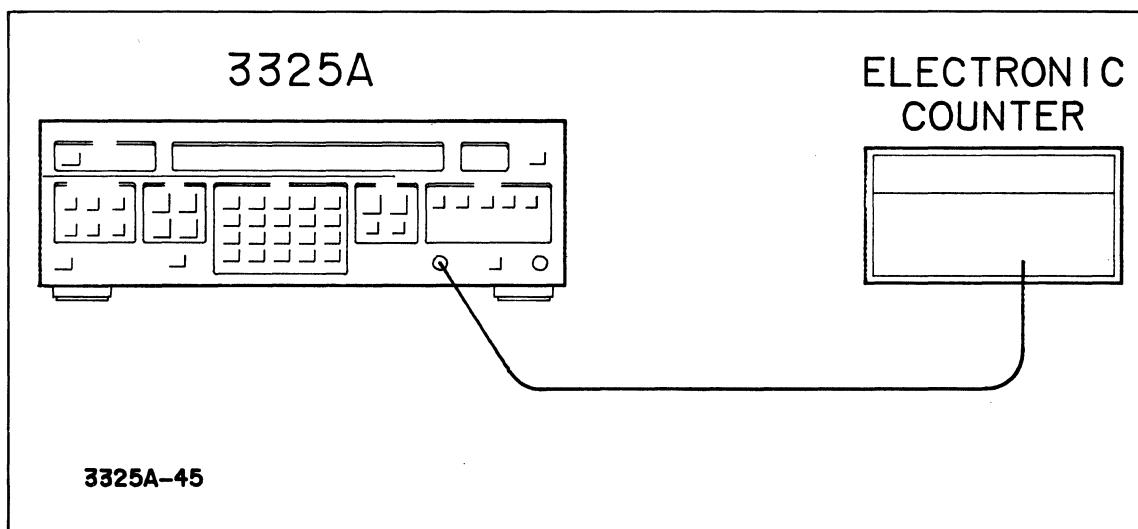


Figure 4-7. Frequency Accuracy.

e. Press the 3325A PHASE entry key to display phase. Using the Modify keys, adjust the phase until the counter reads approximately 200 nanoseconds. Press the 3325A blue entry prefix key, then ASGN ZERO PHASE.

f. Set the electronic counter sample rate to HOLD. Press RESET. Record the counter reading (to 2 decimal places) on the Performance Test Record in the space for "Zero Phase Time Interval". This is the phase difference (in nanoseconds) between the 3325A output and the reference signal.

g. Set the 3325A phase to -1° .

h. Press the electronic counter RESET. Record the counter reading (to 2 decimal places) in the space for "1° Increment Time Interval".

i. Determine the time difference between the counter readings in Step h and Step f, and record in the "Time Difference" column. The difference should be from 22.22 ns to 33.34 ns.

j. Set the 3325A phase to -10° .

k. Press the electronic counter RESET. Record the counter reading to the space for "10° Increment Time Interval".

l. Enter the time difference between the "Zero Phase Time Interval" and the reading in Step k in the "Time Difference" column. This should be from 272.22 ns to 283.34 ns.

m. Set the 3325A phase to -100° .

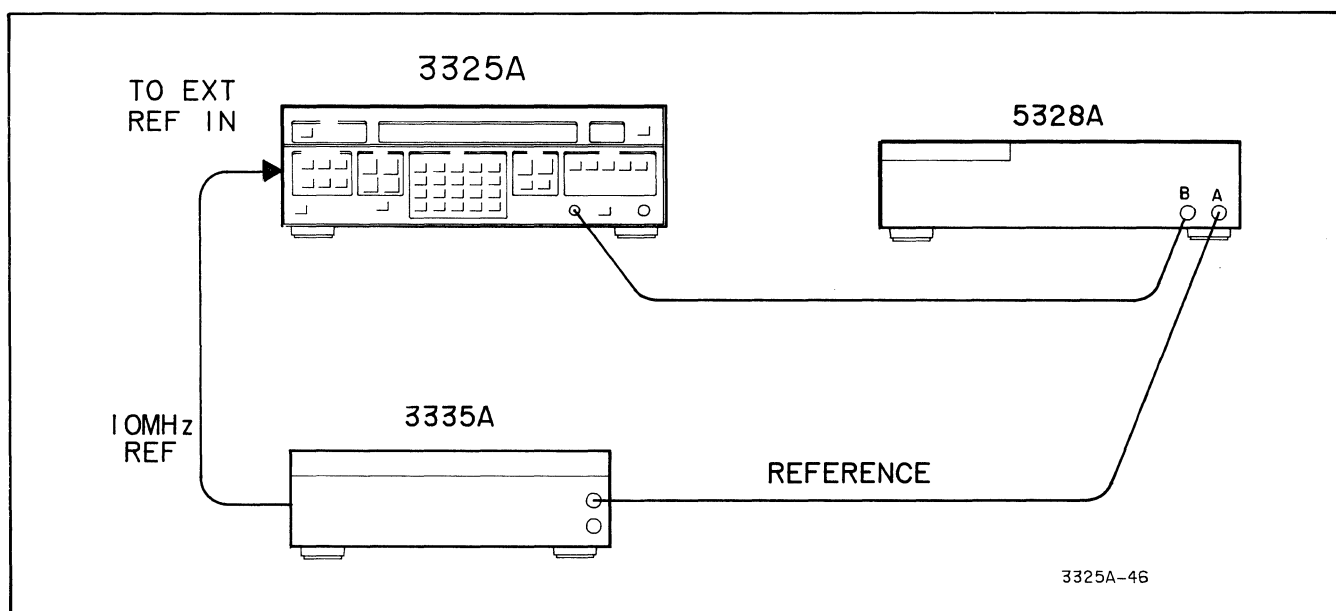


Figure 4-8. Phase Increment Accuracy.

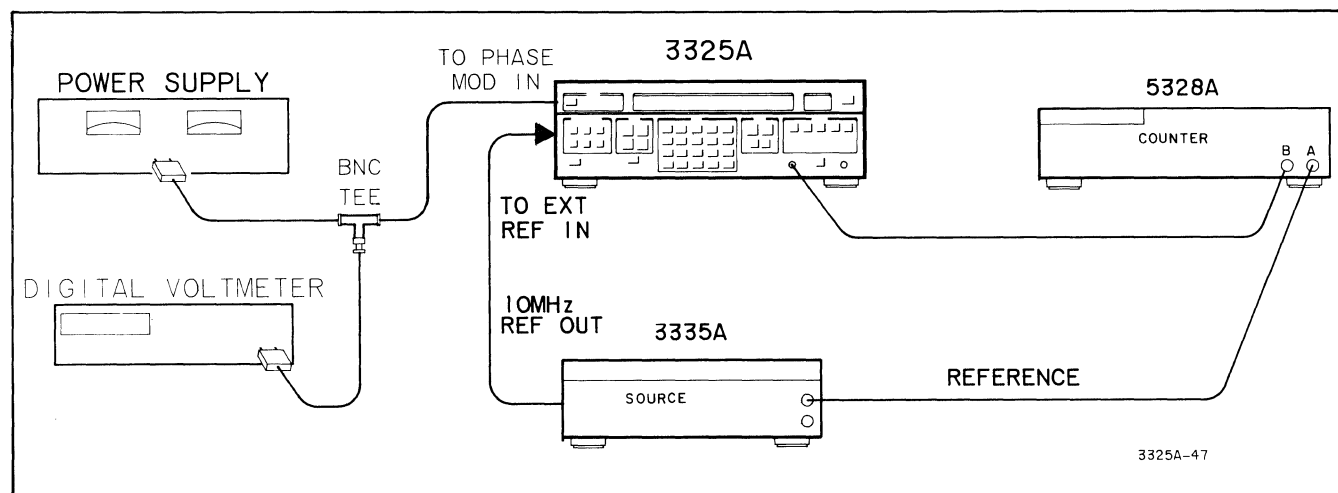


Figure 4-9. Phase Modulation Linearity.

n. Press the electronic counter RESET. Record the counter reading in the space for "100° Increment Time Interval".

o. Enter the time difference between the "Zero Phase Time Interval" and the reading in Step n in the "Time Difference" column. It should be from 2722.22 ns to 2783.34 ns.

4-57. Phase Modulation Linearity.

4-58. This procedure tests the phase modulation linearity. The specification in Table 1-1 is:

$\pm 0.5\%$, best fit straight line

Equipment Required:

Sine wave signal source (-hp- Model 3335A)
Electronic counter (-hp- Model 5328A)
DC power supply (-hp- Model 6214A)
Digital voltmeter (-hp- Model 3455A)

a. Connect the equipment as shown in Figure 4-9.

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
Function Sine
Frequency 100 Hz
Amplitude 13 dBm
Phase Modulation On

c. Set the sine wave signal source (3335A) as follows:

Frequency 100 Hz
Amplitude 13 dBm

d. Set the electronic counter (5328A) as follows:

Function Time Interval Avg. A and B
Frequency Resolution, N 10^5
Inputs 50 Ω , Separate
Slope A and B Positive
Sample Rate Maximum

e. Using the digital voltmeter to monitor the dc power supply output, set the dc voltage as near -5.0000 V as possible.

f. Press the 3325A PHASE entry key to display phase. Using the Modify keys, adjust the phase until the counter reads approximately 200 nanoseconds. Record the counter reading as a reference for the following steps.

g. As soon as possible after recording the counter reading, note the digital voltmeter reading and record on the Performance Test Record in the "DVM Reading, x_1 " space.

h. Press the 3325A blue prefix key, then ASGN ZERO PHASE.

i. Change the dc power supply output to -4.0000 V.

j. Using the Modify keys, adjust the 3325A phase to return the counter reading to the value recorded in Step f.

k. Record the digital voltmeter reading in the "DVM Reading, x_2 " space.

l. The 3325A display indicates the phase change resulting from the 1 V change in modulating voltage. Record the phase display in the "Phase Difference, 2" space (positive value).

m. Press the 3325A blue prefix key, then ASGN ZERO PHASE.

n. Change the power supply output to the following voltages and repeat Steps j through m for each. Record the dvm readings and phase differences in the appropriate spaces on the Performance Test Record.

DC Voltage	DVM Reading	Phase Difference
-3.0000 V	x_3	3
-2.0000 V	x_4	4
-1.0000 V	x_5	5
0.0000 V	x_6	6
+1.0000 V	x_7	7
+2.0000 V	x_8	8
+3.0000 V	x_9	9
+4.0000 V	x_{10}	10
+5.0000 V	x_{11}	11

o. Enter the cumulative phase change in the "Cumulative Phase" column. That is, enter the "2" Phase Difference in the y_2 space, then add the " y_2 " and "3" values and enter in the y_3 space. Add the " y_3 " and "4" values and enter in y_4 , etc.

p. On the Performance Test Record, multiply each x value by the corresponding y value and enter in the "x times y" column.

q. Total the "DVM Reading" column and enter in the Σx space. Total the "Cumulative Phase" values and enter in the Σy space. Total the "x times y" values and enter in the Σxy space.

r. Square each x value and enter in the " x^2 " column. Total this column and enter in the Σx^2 space.

s. Square the Σx value and enter in the $(\Sigma x)^2$ space.

t. Multiply the Σx value by the Σy value and enter in the $\Sigma x \Sigma y$ space.

u. The equation for determining the "best fit straight line" specification for each y value is:

$$y = a_1 x + a_0$$

Where: $a_1 x$ and a_0 are constants to be calculated from data taken previously

Where: x is the value of the modulating voltage, recorded as x_1 through x_{11}

v. First determine the value of a_1 using the following equation:

Where: Σx , Σy , Σxy , $\Sigma x \Sigma y$, Σx^2 , and $(\Sigma x)^2$ are the previously calculated values entered on the Performance Test Record

$n = 11$ (the number of points to be calculated)

w. Determine the value of a_0 using the equation:

$$a_0 = \frac{y}{a_1} - \frac{x}{n}$$

x. Calculate each value for y using the equation: $y = a_1 x + a_0$. Enter each result on the Performance Test Record in the "Best Fit Straight Line Values" column, (y_1 through y_{11}).

y. Determine the test limits for each y value by increasing and decreasing the calculated (y) values by 0.5% of the (y_{11}) value. Enter in the Maximum and Minimum columns.

z. Transfer the y_1 through y_{11} "Cumulative Phase" entries to the "Measured Cumulative Phase" column. Each value should be within the calculated limits.

4-59. Amplitude Accuracy.

4-60. This procedure tests the amplitude of the 3325A ac function output signals against the accuracy specifications in Table 1-1.

Equipment Required:

AC/DC digital voltmeter (-hp- Model 3455A, average converter opt. 001 preferred)

AC: Accuracy sufficient to verify a 1% specification to 100 kHz.

DC: Resolution, 1 microvolt.

High speed DC voltmeter (-hp- Model 3437A). At least $3\frac{1}{2}$ -digit resolution, $1\frac{1}{2}$ microsec. or faster settling time.

50-Ohm step attenuator (-hp- Model 355C)

50-Ohm feedthru termination (-hp- Model 11048C)

Thermal converter (-hp- Model 11050A)

Oscilloscope (-hp- Model 1740A) Must have delayed sweep of .05 microsec/div and delayed sweep gate output.

Components:

Resistor 36.55 ohm 0.1% 0.125W 2 ea 0698-7169

Resistor 61.11 ohm 0.1% 0.25W 2 ea 0699-0090

Resistor 430ohm* 0.1% 0.125W 1 ea 0698-8264

Resistor 1330ohm* 0.1% 0.25W 3 ea 0698-7453

Capacitor 300 pF* 5% 1 ea 0160-2207

*Used only to test High Voltage (option 002).

Amplitude Accuracy at Frequencies up to 100 kHz

a. Sine Wave Test. Connect the 3325A signal output through a 50 ohm feedthrough termination to the AC digital voltmeter input.

- b. Set the 3325A as follows:
- | | |
|----------------------------------|----------------------------------|
| High Voltage Output (Option 002) | Off |
| Function | Sine |
| Frequency | 100 Hz |
| Amplitude | 3.536 V _{RMS} (10 Vp-p) |
| DC Offset | 0 V |
- c. Press AMPTD CAL key.
- d. Read AC Voltmeter. Change 3325A frequency to 1 kHz and 100 kHz and repeat. Verify that all three voltmeter readings are between 3.495 V_{RMS} and 3.577 V_{RMS} (± 0.1 dB).
- e. Change 3325A amplitude to 1.061 V_{RMS} (3 Vp-p) and take ac voltage readings for 100 Hz, 1 kHz and 100 kHz as above. Verify that all three voltmeter readings are between 1.048 V_{RMS} and 1.073 V_{RMS} (± 0.1 dB).
- f. Change 3325A amplitude to .3536 V_{RMS} and set dc offset to 1 mV. Set 3325A frequency to (100 Hz, 1 kHz, and 100 kHz and read ac voltage. Verify that all three readings are between .3411 V_{RMS} and .3660 V_{RMS} (± 0.3 dB).
- g. Function Test. Connect 3325A sync output to external trigger input of oscilloscope. Connect 3325A signal output to the voltage divider of Figure 4-10(A). Connect the voltage divider output to oscilloscope vertical input and to high speed voltmeter input. Connect delayed sweep gate from oscilloscope to external trigger input of high speed voltmeter. See Figure 4-10A.
- h. Set the 3325A as follows:
- | | |
|--------------------------------|---------|
| High Voltage Output (Option 2) | OFF |
| DC Offset | 0 V |
| Amplitude | 10 Vp-p |
| Frequency | 99.9 Hz |
| Function | Square |
- i. Set the oscilloscope as follows:
- | | |
|----------------------|-----------------|
| Display | A or B |
| Vertical Sensitivity | .5 volts/div |
| Trigger | Ext |
| Main Sweep | 1 msec/div |
| Delayed Sweep | 5 μ sec/div |
| Delay | 250 |
- j. Set the 3437A voltmeter as follows:
- | | |
|---------|-------|
| Range | 1.0 V |
| Trigger | Ext |
| Delay | 0 sec |
- k. One cycle of the square wave should fill the screen of the oscilloscope, and the sample time for the voltmeter should be seen as the intensified spot of the delayed sweep.
- l. Press AMPTD CAL on the 3325A.
- m. Read positive peak voltage of attenuated waveform on voltmeter. If the reading is not stable, press hold, then ext. alternatively to repeat readings. Change oscilloscope delay to 750 and read negative peak. Add the two readings to obtain volts peak to peak. Verify that sum is between 3.661 volts and 3.735 volts.
- n. Change 3325A function to Triangle. Change oscilloscope to:
- | | |
|----------------------|-----------------|
| Vertical Sensitivity | .2 volts/div |
| Vertical Position | 9 o'clock |
| Main Sweep | .5 msec/div |
| Delay | 500 |
| Magnify | X10 |
| Delayed Sweep | 1 μ sec/div |
- o. Adjust oscilloscope delay to place the intensified spot on peak of triangle and read positive peak voltage on 3437A. Press neg trigger, move vertical position knob of CR0 to 3 o'clock and adjust intensified spot to read negative peak on the 3437A. Verify that sum of positive and negative peak voltages is between 3.643 and 3.754 volts.
- p. Change 3325A function to pos ramp. Change oscilloscope to:
- | | |
|------------|------------|
| Trigger | pos |
| Main Sweep | 2 msec/div |
- Place spot on positive peak, press hold, then ext, then hold a few times on the 3437A and record most positive reading.
- q. Move vertical position knob to 3 o'clock, adjust delay and read negative peak. Ramp jitter should be visible on all ramp readings (the 3437A will hold the readings). Verify that sum of pos and neg peaks is between 3.643 and 3.754 volts.
- r. Change 3325A function to neg ramp. Change CRO trigger to pos and take neg ramp reading as above.
- s. Change 3325A function to square and frequency to 1 kHz. Set CR0 as follows:
- | | |
|---------------|-------------------|
| Main Sweep | 50 μ sec/div |
| Delayed Sweep | .05 μ sec/div |
- Read positive peak; push neg trigger and read negative peak. Verify that sum is between 3.661 and 3.735 volts.
- t. Change 3325A function to triangle and frequency to 2 kHz. Set CRO main sweep to 20 μ sec/div and delay to 610. Adjust delay and position and set pos and neg trigger to read peaks. Verify Vp-p to be between 3.643 and 3.754 volts.
- u. Change 3325 function to pos ramp and frequency to 500 Hz. Set main sweep of CRO to .2 msec/div and adjust sweep vernier to return peaks to center screen (trigger must be neg to see jitter at this point). Verify Vpp to be between 3.643 and 3.754 volts.

v. Change 3325A function to neg ramp and CRO trigger to pos. Verify Vpp of 3.643 to 3.754 volts.

w. Change 3325A frequency to 100 kHz and function to square. Return CRO sweep vernier to calibrate and set main sweep to .5 μ sec/div and magnify to off. Read pos and neg peak voltages in the center of the screen. By pressing pos/neg trigger. Verify Vpp of 3.661 to 3.735 volts.

x. Change 3325A function to triangle (frequency will go to 10 kHz). Set CRO main sweep to 5 μ sec/div and press magnify. Verify Vpp of 3.513 to 3.883 volts.

y. Change 3325A function to pos ramp. Set cro main sweep to 20 μ sec/div. Adjust delay to set end of intensified spot on highest peak. Verify Vpp of 3.328 to 3.996 volts.

z. Change 3325A function to neg ramp. Verify Vpp of 3.328 to 3.996 volts.

aa. Change 3325A amplitude to 3 Vpp, and remove the voltage divider from the circuit. Set frequency to 99.9 Hz and function to square.

bb. Repeat tests i through z. New test limits are as follows:

Test	Frequency	Function	Minimum	Maximum
m	99.9 Hz	Square	2.970 V	3.030 V
o	99.9 Hz	Triangle	2.955 V	3.045 V
q	99.9 Hz	Pos Ramp	2.955 V	3.045 V
r	99.9 Hz	Neg Ramp	2.955 V	3.045 V
s	1 kHz	Square	2.970 V	3.030 V
t	2 kHz	Triangle	2.955 V	3.045 V
u	500 Hz	Pos Ramp	2.955 V	3.045 V
v	500 Hz	Neg Ramp	2.955 V	3.045 V
w	100 kHz	Square	2.970 V	3.030 V
x	10 kHz	Triangle	2.850 V	3.150 V
y	10 kHz	Pos Ramp	2.700 V	3.300 V
z	10 kHz	Neg Ramp	2.700 V	3.300 V

cc. Change 3325A amplitude to 1 Vpp, and set dc offset to 1 mV. Set frequency to 99.9 Hz and function to square. Set CRO vertical sensitivity to .05 volts/div for all 1 Vpp tests.

dd. Repeat tests i through z. New test limits are as follows:

Test	Frequency	Function	Minimum	Maximum
m	99.9 Hz	Square	.970	1.030
o	99.9 Hz	Triangle	.960	1.040
q	99.9 Hz	Pos Ramp	.960	1.040
r	99.9 Hz	Neg Ramp	.960	1.040
s	1 kHz	Square	.970	1.030
t	2 kHz	Triangle	.960	1.040
u	500 Hz	Pos Ramp	.960	1.040
v	500 Hz	Neg Ramp	.960	1.040
w	100 kHz	Square	.970	1.030
x	10 kHz	Triangle	.940	1.060
y	10 kHz	Pos Ramp	.890	1.110
z	10 kHz	Neg Ramp	.890	1.110

High Voltage Output Amplitude Accuracy For Frequencies To 100 kHz

(For Instruments with High Voltage Option 002)

ee. **Sine Wave Test.** Connect 3325A signal output to the AC voltmeter via a 6 ft. cable. Connect a 500 Ω , 300 pF load (at either end) in parallel with the line.

ff. Press the 3325 high voltage key near the 3325A output connector. A LED in the key indicates that the high voltage output is on.

gg. Set 3325A function to sine, frequency to 2 kHz, and amplitude to 14.14 V_{RMS} (40 Vpp). Press AMPTD CAL key. The AC voltmeter reading should be 13.86 to 14.42 V_{RMS}.

hh. **High Voltage Function Test.** Connect 3325A signal output to CRO and voltage divider via a 6 ft. cable. Trigger CRO on 3325A sync output. Trigger high speed DC voltmeter on delayed sweep gate from CRO. See Figure 4-10(B).

ii. The voltage divider shown in Figure 4-10(B) is built into a small metal box with 2 BNC connectors. Parts used are:

R3, 443 ohm, consists of 3 parallel 1330 ohm resistors, each 0.1%, 0.25 watt, -hp- Part Number 0698-7453

R4, 43 ohm, 0.1%, 0.125 watt, -hp- Part No. 0698-8264

C1, 300 pF, 5%, -hp- Part Number 0160-2207

Connect the tap to the input of high speed DC voltmeter as shown in Figure 4-10(B).

jj. Set 3325A frequency to 2 kHz and amplitude to 40 Vpp. Set DC voltmeter to 1V range and ext trigger. Set oscilloscope as follows:

Vertical Sensitivity	2 volts/div
Vertical Position	8 o'clock
Trigger	Ext
Main Sweep	20 μ sec/div
Delayed Sweep	.05 μ sec/div
Delay	615
Magnify	X10

kk. Set 3325A to square wave and read positive peak on DC voltmeter. Switch CRO to neg trigger, take vertical position to 4 o'clock, and read neg peak. Verify that peak to peak voltage is between 3.466 and 3.607 volts.

ll. Change 3325A function to triangle, and read peak voltages. Vpp should be 3.466 to 3.607 volts.

mm. Change 3325A to pos ramp. Change CRO main sweep to .1 msec/div and delay to 500. Verify Vpp of 3.466 to 3.607 volts. Repeat for neg ramp by changing CRO trigger to pos.

Amplitude Flatness: (Frequencies above 100 kHz)

nn. Set the 3325A as follows:

High Voltage Output (Option 2)	OFF
Function	Sine
Frequency	1 kHz
Amplitude	3 Vpp

oo. Set the 50 Ω attenuator (-hp- Model 355C) to 3 dB and connect to signal output. Connect 1 V_{RMS} thermal converter (-hp- 11050A) to attenuator output. Connect DC digital voltmeter with microvolt resolution (-hp- 3455A) to thermal converter output. See Figure 4-10(C).

pp. Press 3325A AMPTD CAL key. Record the voltmeter reading in the 3 V sine wave 1 kHz reference space on the performance test record.

qq. Set the 3325A modify key to the 1 MHz position and bump the frequency in 2 MHz steps from 1 kHz to 20,001 MHz, recording the voltmeter reading at each frequency.

rr. Verify that all flatness readings are within $\pm 6.6\%$ of the 1 kHz reference reading.

ss. Change attenuator to 12 dB. Change 3325A amplitude to 10 Vpp. Repeat steps pp and qq for 10 Vpp. Verify that all readings are within 6.3% of the 1 kHz reference.

tt. Disconnect the thermal converter from the 3325A output.

uu. Square wave flatness. Set the 3325A as follows:

High Voltage Output (Option 2)	OFF
Function	Square
Amplitude	10 Vpp
Frequency	1 kHz

vv. Connect the 3325A signal output to an oscilloscope (-hp- 1740A) with a 50 Ω load. Set the oscilloscope as follows:

Vertical Sensitivity	2 volts/div
Time/Div	.1 msec

ww. Use the modify keys to bump the 3325A frequency from 1 kHz to 10.001 MHz in 2 MHz steps. Two lines will appear on the oscilloscope. Verify that they remain within $\frac{1}{2}$ major division of 5 divisions apart for all 11 frequencies.

xx. High Voltage (Option 2) Amplitude Flatness above 100 kHz.

yy. Connect the 3325A output to an oscilloscope (-hp- 1740A) with a 500 Ω , 500 pF load (load attached at either end). Cable capacitance (30pF/foot) must be included in the 500 pF. The HV divider (Figure 4-10(B)) may be used with 6 feet of cable.

zz. Set the oscilloscope as follows:

Vertical Sensitivity	10 volts/div
Time/Div	1 msec

aaa. Set the 3325A to 40 Vpp sine wave (HV option on) and 1 kHz. Adjust oscilloscope intensity and focus for a sharp trace.

bbb. Use the modify keys to bump the 3325A frequency from 1 kHz to 1.001 MHz in 200 kHz steps. Verify that the width of the bright region of the screen is $4 \pm .4$ divisions for all 11 frequencies.

4-61. DC Offset Accuracy (DC Only).

4-62. This procedure tests the dc offset accuracy when no ac function output is present. The dc only specification in Table 1-1 is:

$\pm 0.4\%$ of full range

Equipment Required:

DC digital voltmeter with 5-digit resolution, capable of measuring >20 V for High Voltage Output Option 002 (-hp- Model 3455A)
50-ohm Feedthru termination (-hp- Model 11048C)

a. Connect the 3325A signal output through the 50-ohm feedthru termination to the dc digital voltmeter input (see Figure 4-11(A)).

b. Press whichever function key is presently active, indicated by a lighted indicator in the center of the key. This removes the ac output. The indicator in the center of the "DC OFFSET" entry key should light.

c. Set the 3325A dc offset to 5 V, then press the "AMPTD CAL" key.

d. The dc digital voltmeter reading should be $+4.980$ to $+5.020$ V.

e. Change 3325A dc offset to -5 V. Digital voltmeter reading should be -4.980 to -5.020 V.

Attenuator Test

f. Set the dc offset to the positive and negative voltages shown below. The digital voltmeter reading should be within the tolerances shown for each voltage.

DC Offset	Tolerances
± 1.499 V	± 1.49300 to 1.50499 V
± 499.9 mV	± 0.49790 to 0.50190 V
± 149.9 mV	± 0.14930 to 0.15050 V
± 49.99 mV	± 0.04979 to 0.05019 V
± 14.99 mV	± 0.01493 to 0.01505 V
± 4.999 mV	± 0.004979 to 0.005019 V
± 1.499 mV	± 0.001479 to 0.001519 V

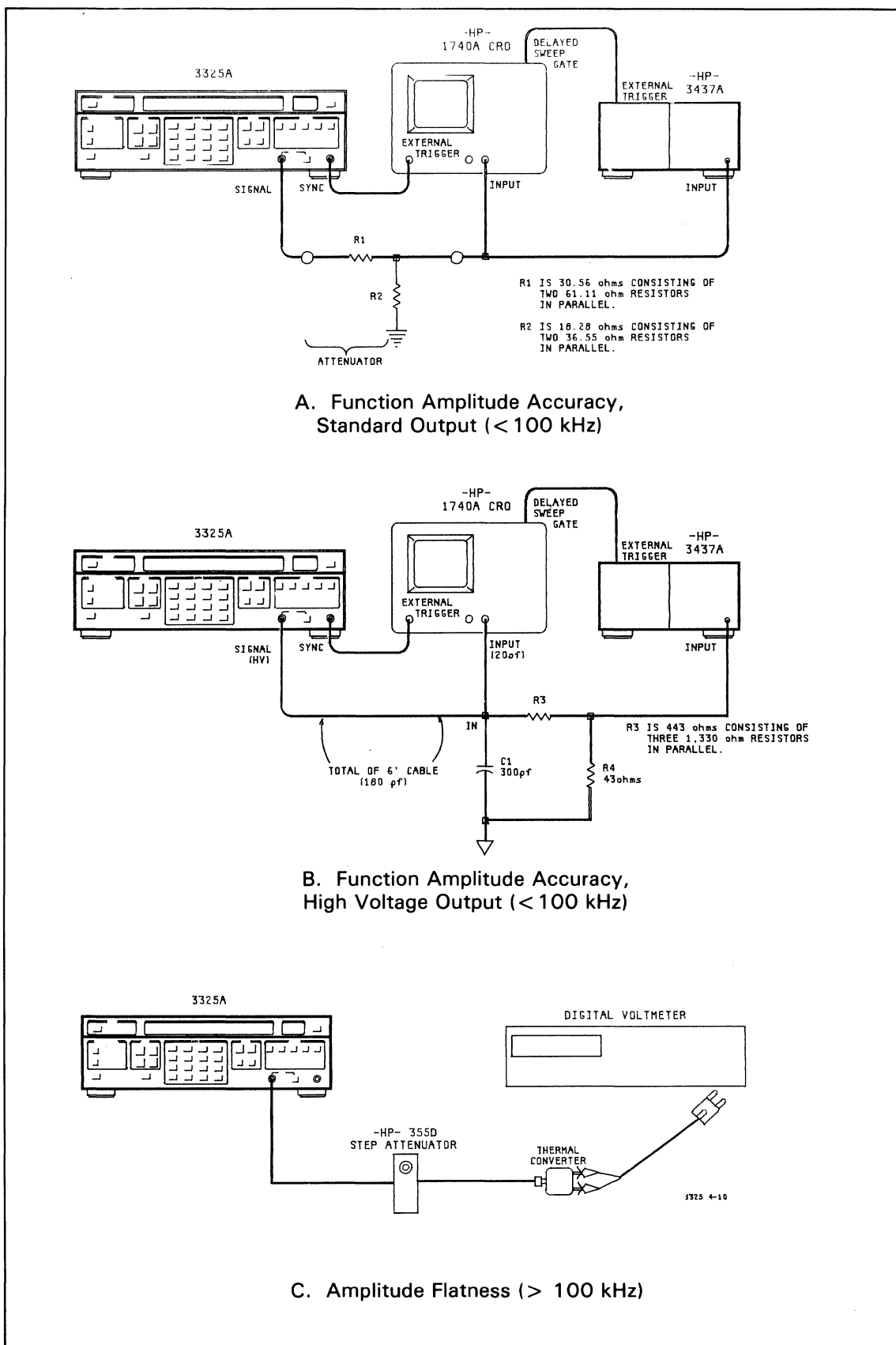


Figure 4-10. Amplitude Accuracy and Flatness.

High Voltage Output Option 002 DC Offset

g. Remove the 50-ohm feedthru and connect the 3325A output directly to the digital voltmeter input.

h. Press the "SIGNAL" key in the lower right corner of the 3325A front panel to select High Voltage Output (Option 002). Lighted indicator in the center of this key indicates High Voltage Output is on.

i. Set 3325A dc offset to 20 V. Digital voltmeter reading should be +19.775 V to 20.225 V.

j. Set 3325A dc offset to -20 V. Digital voltmeter reading should be -19.775 V to -20.225 V.

4-63. DC Offset Accuracy with AC Functions.

4-64. The specifications for DC Offset accuracy with AC Functions given in Table 1-1 are as follows:

DC + AC, ≤ 1 MHz: $\pm 1.2\%$, Ramps $\pm 2.4\%$
DC + AC, > 1 MHz: $\pm 3\%$

Equipment Required:

DC Digital voltmeter (-hp- Model 3455A)
50-ohm feedthru termination (-hp- Model 11048C)

a. Connect the equipment as shown in Figure 4-11(A). Set the digital voltmeter to measure dc voltage.

b. Set the 3325A output as follows:

High Voltage Output (Option 002) Off
Function Sine
Frequency 20.999 999 999 MHz
Amplitude 1 V p-p
DC Offset +4.5 V

c. Press AMPTD CAL key. After amplitude calibration (approximately 2 seconds) the digital voltmeter reading should be +4.350 to +4.650 V dc.

d. Change the dc offset to -4.5 V. Digital voltmeter reading should be -4.350 to -4.650 V dc.

e. Change the 3325A frequency to 999.9 kHz. The digital voltmeter reading should be -4.440 to -4.560 V dc.

f. Change the 3325A dc offset to (+) 4.5 V. The digital voltmeter reading should be +4.440 to +4.560 V dc.

g. Set the 3325A function to Square. The digital voltmeter reading should be +4.440 to +4.560 V dc.

h. Change the 3325A dc offset to -4.5V. The digital voltmeter reading should be -4.440 to -4.560 V dc.

i. Change the 3325A frequency to 9.9999 MHz. The digital voltmeter reading should be -4.350 to -4.650 V.

j. Set the 3325A function to Triangle, frequency to 9.9 kHz. The digital voltmeter reading should be -4.440 to -4.560 V.

k. Set the 3325A function to + Ramp. The digital voltmeter reading should be -4.380 to -4.620 V.

4-65. Triangle Linearity.

4-66. This procedure tests the linearity of the triangle wave output against the specification in Table 1-1:

$\pm 0.05\%$ of full output, 10% to 90%, best fit straight line

Because the triangle and ramp outputs are generated by the same circuits, this procedure effectively tests the ramp linearity also.

Equipment Required:

High-speed dc digital voltmeter (This procedure is written to use the high speed and delay capabilities of the -hp- Model 3437A)

Resistive divider, $\div 2.5$, consisting of:

30 ohms $\pm 1\%$ $\frac{1}{4}$ W (-hp- Part No. 0698-7533)

20 ohms $\pm 1\%$ $\frac{1}{4}$ W (-hp- Part No. 0698-6296)

BNC-to-Triax adapter (-hp- Part No. 1250-0595 or Model 11172A RF Cable)

a. Connect the 3325A and the high-speed digital voltmeter through the divider as shown in Figure 4-11(B).

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
Function Triangle
Frequency 10 kHz
Amplitude 10 V p-p

c. Set the digital voltmeter as follows:

Range 1 V
Number of Readings 1
Trigger Ext

NOTE

The Model 3437A triggers on the negative-going edge of the 3325A sync square wave.

d. Set the digital voltmeter delay to .00003 (seconds). Record the digital voltmeter reading on the Performance Test Record under "Positive Slope Measurement, (10%) y_1 ". This is the 10% point on the positive slope of the triangle. See Figure 4-12.

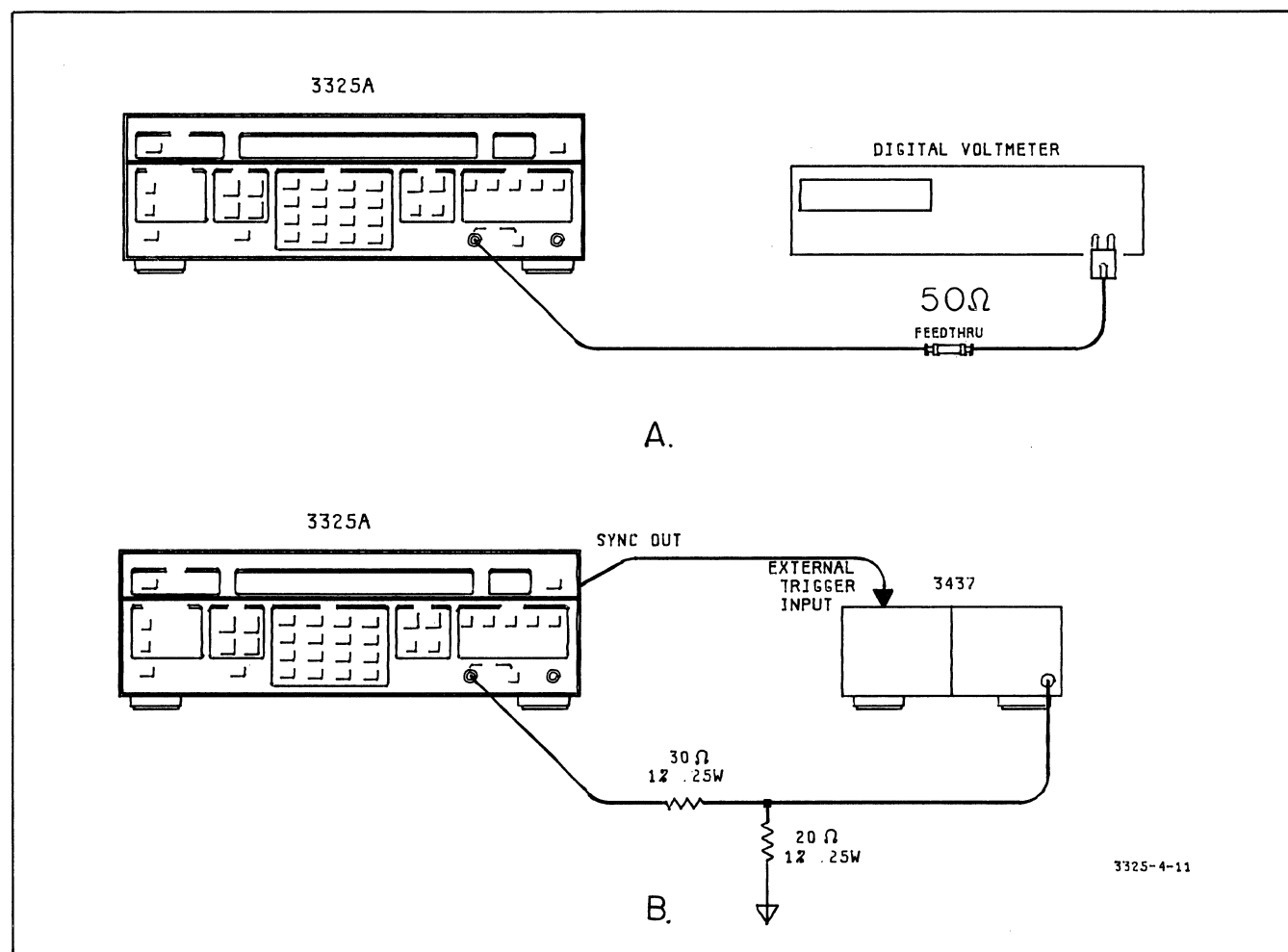


Figure 4-11. Triangle and Ramp Linearity Test.

e. Measure the voltage at each 10% segment point by setting the digital voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under "Positive Slope Measurement."

Delay	Percent of Slope
.000035	20
.00004	30
.000045	40
.00005	50
.000055	60
.00006	70
.000065	80
.00007	90

f. Measure the voltage at each 10% segment point on the negative slope by setting the digital voltmeter delay to the following. Enter the readings on the Performance Test Record in the appropriate spaces under "Negative Slope Measurement."

Delay	Percent of Slope
.00008	90
.000085	80
.00009	70
.000095	60
.0001	50
.000105	40
.00011	30
.000115	20
.00012	10

g. Algebraically add the voltages recorded in the "Positive Slope Measurement" column and enter the total in the "Σy" space.

h. Multiply Σy by 45 (which is Σx) and enter the result in the "ΣxΣy" space.

i. Multiply each y value by the corresponding x value and enter in the "x times y" column. Total these values and enter in the "Σxy" space.

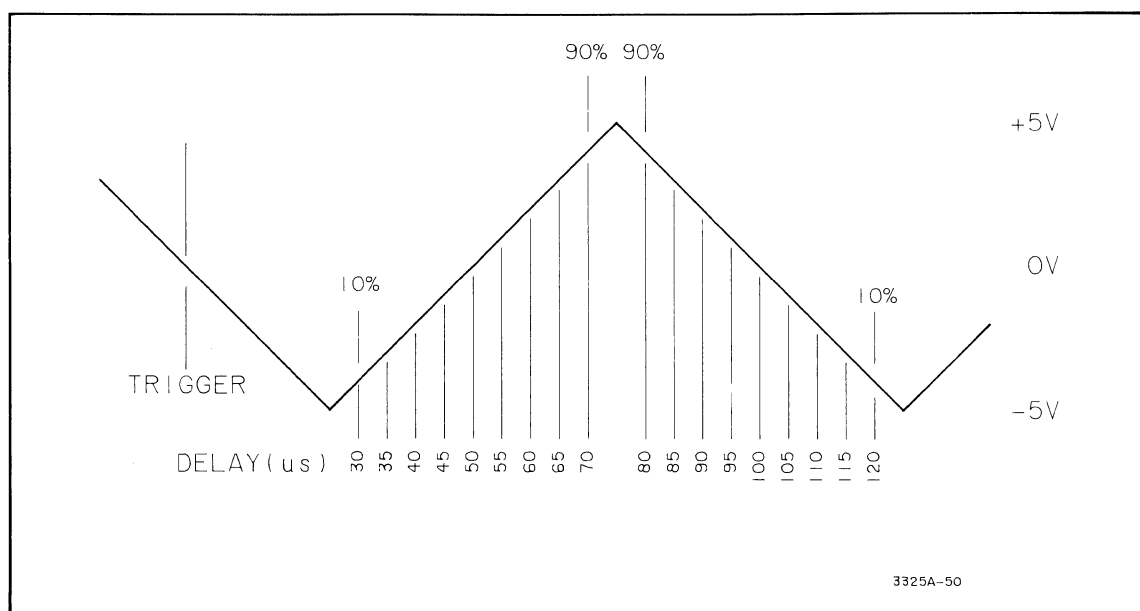


Figure 4-12. Triangle Linearity Test.

j. The equation for determining the “best fit straight line” specification for each y value is:

$$y = a_1x + a_0$$

Where: a_1 and a_0 are constants to be calculated from data taken previously.

NOTE

Calculate the values of a_1 and a_0 to at least five decimal places.

k. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

Where: Σx , Σy , Σxy , $\Sigma x \Sigma y$, Σz^2 , and $(\Sigma x)^2$ are the previously calculated values entered on the Performance Test Record.

$n = 9$ (the number of points to be calculated)

l. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - a_1 \frac{\Sigma x}{n}$$

m. Calculate the “Best Fit Straight Line” value for each point (y_1 through y_9) using the equation:

$$y = a_1x + a_0$$

Enter each result on the Performance Test Record in the “Best Fit Straight Line” column.

n. Determine the minimum and maximum allowable voltages at each point by subtracting and adding 0.002 V to the voltages calculated in Step m ($10 \text{ V} \div 2.5 \times 0.05\%$). Enter these voltage limits on the Performance Test Record under “Minimum” and “Maximum”. The voltages measured and recorded in the “Positive Slope Measurement” column should be within these calculated tolerances.

o. Algebraically add the voltages recorded in the “Negative Slope Measurement” column and enter the total in the “ Σy ” space.

p. Repeat Steps h through n to determine the “Best Fit Straight Line” values and tolerances for the negative slope. The voltages measured and recorded in the “Negative Slope Measurement” column should be within the calculated tolerances.

4-67. X Drive Linearity.

4-68. This procedure tests the linearity of the rear panel X Drive output to the specification in Table 1-1: for all linear sweep widths which are integral multiples of the minimum sweep width for each function and sweep time:

$\pm 0.1\%$ of final value, 10% to 90%, best fit straight line.

Equipment Required:

High-speed dc digital voltmeter (This procedure is written to use the high speed and delay capabilities of the -hp- Model 3437A)

Resistive divider, $\div \sim 2.6$, consisting of:

100k Ω 1% 1/8W (-hp- Part No. 0757-0465)

162k Ω 1% 1/8W (-hp- Part No. 0757-0470)

DC power supply (-hp- Model 6214A)

BNC-to-Triax adapter (-hp- Part No. 1250-0595 Model 11172A RF Cable)

a. Connect the equipment as shown in Figure 4-13.

b. Set the 3325A as follows:

High Voltage Output (Option 002) Off
 Function Sine
 Amplitude 10 V p-p
 Sweep Start Frequency 1 MHz
 Sweep Stop Frequency 10 MHz
 Sweep Marker Frequency4 MHz
 Sweep Time 0.01 sec

c. Press 3325A START CONT key.

d. Set the digital voltmeter as follows:

Range 1 V
 Number of Readings 1
 Trigger Ext

NOTE

The Model 3437A triggers on the negative-going edge of the Z Blank signal, which occurs at the start of a sweep up.

e. Set the digital voltmeter delay to .001 (seconds). Adjust the dc power supply for a digital voltmeter reading of -1.600 V. Record the digital voltmeter reading on the Performance Test Record under "X Drive Ramp Measurement, (10%), y_1 ." This is the 10% point on the X Drive ramp. See Figure 4-14.

f. Measure the voltage at each 10% segment point by setting the digital voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under "X Drive Ramp Measurement".

Delay	Percent of Ramp
.002	20
.003	30
.004	40
.005	50
.006	60
.007	70
.008	80
.009	90

g. Algebraically add the voltages recorded in the "X Drive Ramp Measurement" column and enter the total in the " Σy " space.

h. Multiply Σy by 45 (which is Σx) and enter the result in the " $\Sigma x \Sigma y$ " space.

i. Multiply each y value by the corresponding x value and enter in the "x times y" column. Total these values and enter in the " Σxy " space.

j. The equation for determining the "best fit straight line" specification for each y value is:

$$y = a_1 x + a_0$$

Where: a_1 and a_0 are constants to be calculated from data taken previously.

NOTE

Calculate the values of a_1 and a_0 to at least five decimal places.

k. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

Where: Σx , Σy , Σxy , $\Sigma x \Sigma y$, Σx^2 , and $(\Sigma x)^2$ are the previously calculated values entered on the Performance Test Record.

$n = 9$ (the number of points to be calculated)

l. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - a_1 \frac{\Sigma x}{n}$$

m. Calculate the "Best Fit Straight Line" value for each point (y_1 through y_9) using the equation:

$$y = a_1 x + a_0$$

Enter each result on the Performance Test Record in the "Best Fit Straight Line" column.

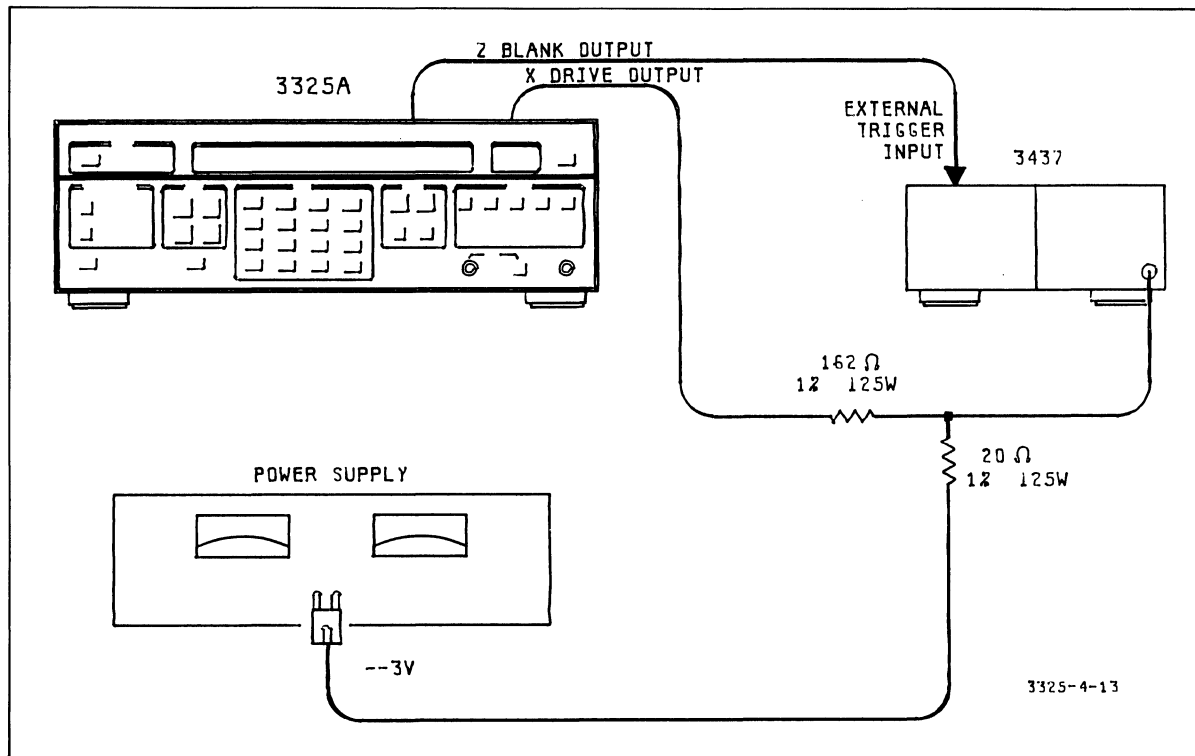


Figure 4-13. X Drive Linearity Test.

n. Determine the minimum and maximum allowable voltages at each point by subtracting and adding 0.004 V to the voltages calculated in Step m ($10.5 \text{ V} \div 2.6 \times 0.1\%$). Enter these voltage limits on the Performance Test Record under "Minimum" and "Maximum". The voltages measured and recorded in the "X Drive Ramp Measurement" column should be within these calculated tolerances.

NOTE

The 3325A X Drive maximum voltage (100%) is set at the factory to +10.5 V..

4-69. Ramp Period Variation.

4-70. This procedure tests the variation between alternate cycles of the positive and negative slope ramps to the specification in Table 1-1: $< \pm 1\%$ of period, maximum.

Equipment Required: Oscilloscope, with delayed sweep (-hp- Model 1740A)

a. Connect 3325A signal output to the oscilloscope vertical input. (Do NOT use a 10:1 probe.) If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load (-hp- Model 11048C 50-ohm Feedthru Termination) at the input.

b. Set the 3325A as follows:

Function.....Negative Slope Ramp
Frequency.....100 Hz
Amplitude.....10 V p-p

c. Set the oscilloscope as follows:

Vertical.....2 V/div
Main sweep.....2.0 ms/div
Delayed sweep.....20 $\mu\text{s}/\text{div}$
Trigger.....Positive

d. With oscilloscope horizontal controls set to main sweep, adjust the intensified portion of the trace to the reset (positive going) portion of the ramp.

e. Set the horizontal controls to delayed sweep and position the ramp reset portion near the center of the display.

f. The reset portion should show more than one line, as in Figure 4-15. The lines should not be separated by more than ten divisions on the display.

g. Change the 3325A function to positive slope ramp and set oscilloscope trigger to negative to verify the positive ramp.

h. Bump the 3325A frequency to 99.999999 Hz to check the low frequency ramps. Verify that ramp period variations do not exceed ten divisions.

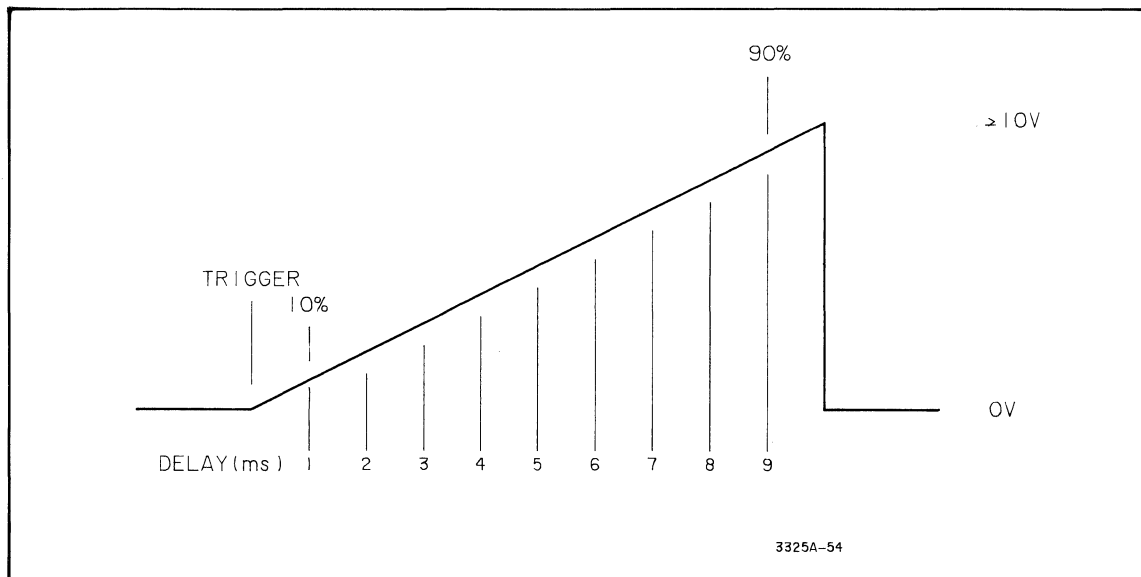


Figure 4-14. X Drive Linearity Test.

4-71. HP-IB Interface Test.

4-72. The following calculator program tests the operation of the 3325A HP-IB interface circuits. The program is written for an -hp- Model 9825A calculator but may be adapted for other controllers. The program is printed on a foldout page for your convenience.

Equipment Required:

- hp- Model 9825A Calculator equipped with:
- 98034A HP-IB Interface (set the select code 7)
- Any combination of ROM's that includes a General I/O ROM and an Extended I/O ROM

a. Connect the calculator interface cable to the 3325A rear panel HP-IB connector. It is recommended that no other equipment be connected to this HP-IB during this test.

b. Enter the program into the calculator.

c. Press RUN. Tests 4 through 7 in this program require the operator to press CONTINUE if the test passes, or 1 CONTINUE if the test fails. If the Test 4 question (SRQ LIGHT ON?, 1 = NO) does not appear in the calculator display within 30 seconds after start of the program (RUN), the 3325A and calculator are not interfacing properly. The calculator may display an error indication that will identify the problem. If not, the 3325A HP-IB circuits are probably not operating correctly.

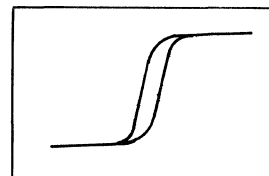
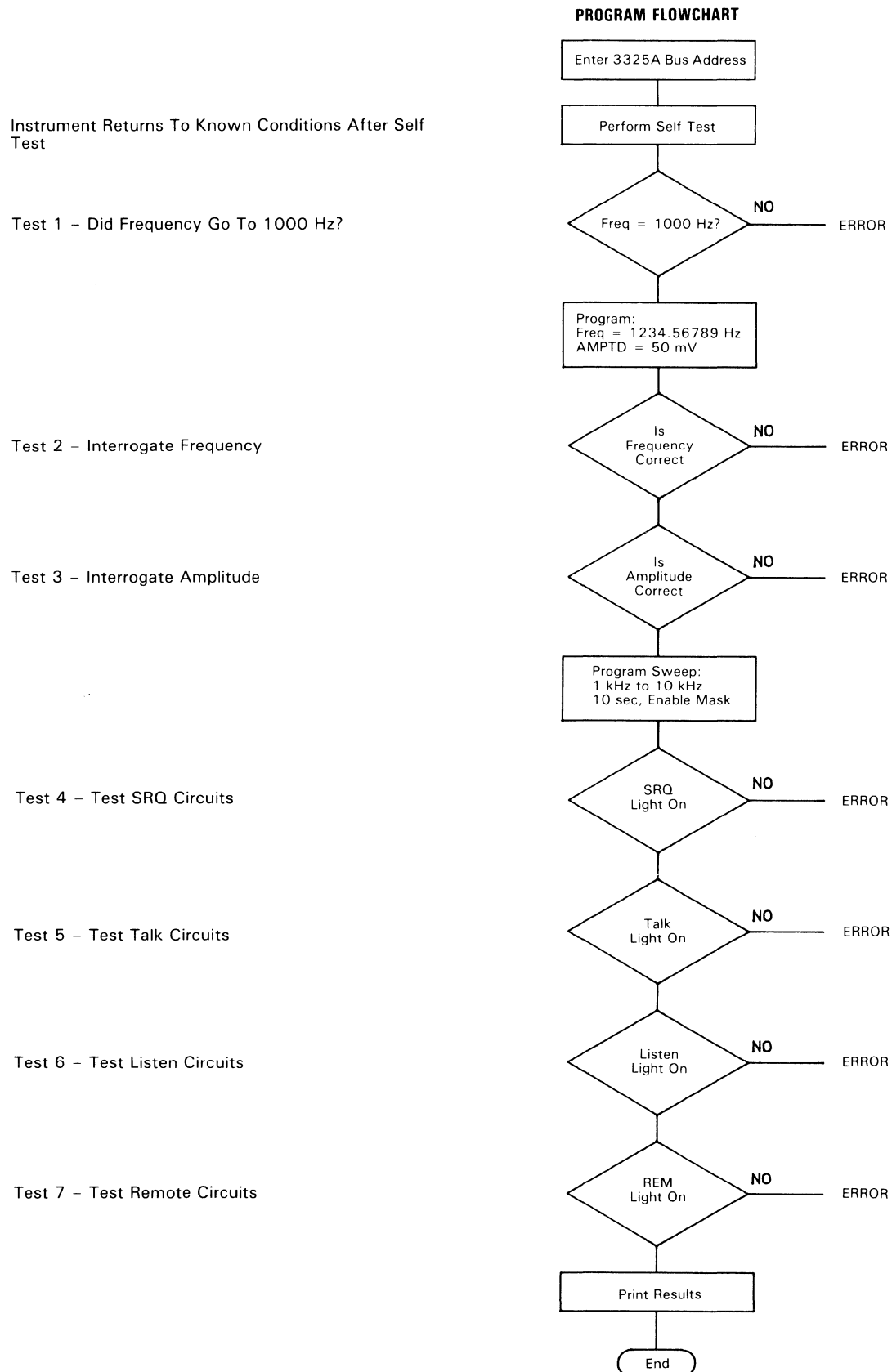


Figure 4-15. Ramp Reset Waveform.




```

0: fnt ;csv;0+r1+r2+r3+r4+r5+r6+r7
1: prt "*****"
2: prt "3325A"
3: prt "HP-IB TEST"
4: prt "*****"
5: beep;ent "3325A BUS ADDRESS?,cont=717",A
6: if f1;13;717→A
7: clr A ————— Clear the 3325A to Turn-on State
8: rem 7 ————— Set HP-IB Remote Enable (Select Code 7)
9:
10: "TEST 1":
11: wrt A,"TE" ————— Perform Self Test
12: wrt A,"IFR" ————— Interrogate Frequency
13: red A,F ————— Read 3325A Frequency
14: if F#1000;1+r1 ————— Compare Frequency to 1000 Hz
15:
16: "TEST 2,3 SETUP":
17: wrt A,"FR1234.567890HZ AM50MV" ————— Set Freq to 1234.567890 Hz, Amptd to 50mV
18: wrt A,"SR3" ————— Store Settings in Register 3
19: clr A ————— Clear the 3325A
20: wrt A,"RE3" ————— Recall Settings in Register 3
21:
22: "TEST 2":
23: wrt A,"IFR" ————— Interrogate Frequency
24: red A,G ————— Read Frequency
25: if G#1234.56789;1+r2 ————— Compare to Frequency Stored
26:
27: "TEST3":
28: wrt A,"IAM" ————— Interrogate Amplitude
29: red A,H ————— Read Amplitude
30: if H#.05;1+r3 ————— Compare to Amplitude Stored
31:
32: "TEST 4":
33: wrt A,"ST1KH SP10KH SM1 TI10SE NSF SSSS" ————— Lin Sweep 1— 10kHz, Enable SRQ Mask
34: cli 7;1cl 7 ————— Clear Interface, Interface to Local
35: beep;ent "SRQ LIGHT ON?,1=NO",r4 ————— Did 3325A Initiate SRQ?
36:
37: "TEST 5":
38: rds(A)+S ————— Read Status into Variable 5
39: rem 7 ————— Set Remote Enable
40: red A,S ————— Read from the 3325A
41: beep;ent "TALK LIGHT ON?,1=NO",r5 ————— Did 3325A respond to Talk Command?
42:
43: "TEST6":
44: wrt A;1cl 7 ————— Write to the 3325A, Interface to Local
45: beep;ent "LISTEN LIGHT ON?,1=NO",r6 ————— Did 3325A respond to Listen Command?
46:
47: "TEST 7":
48: rem 7;wrt A;cli 7 ————— Remote Interface, Write to 3325A, Clear Interface
49: beep;ent "REMOTE LIGHT ON?:1=NO",r7 ————— Did the 3325A Respond to Remote?
50:

```

```

51: spc ;prt "*****"
52: prt "TEST RESULTS:"
53: spc ;1+I;fxd 0
54: if rI=0;prt "TEST",I,"      PASS"
55: if rI=1;prt "TEST",I,"      FAIL"
56: if (I+1+I)<=7;jmp -2
57: prt "*****";spc 3
58: ent "Repeat test?,1=Yes";C;if C=1;eto 0
59: end
*24386

```

Print Results of Tests

Self Contained Program may be Linked or Used as a Subroutine

Variables used in this Test Program:

A Address of 3325A (defaults to 717)
 F Frequency read from 3325A in test #1
 G Frequency read from 3325A in test #2
 H Amplitude read from 3325A in test #3
 I Counter used to print test results
 r1-r7 Test results (0=Pass, 1=Fail)
 S Status read from 3325A in test #5

Samples of Program Printouts:

```

*****
3325A
HP-IB TEST
*****

```

```

*****
TEST RESULTS:

```

```

TEST          1
PASS
TEST          2
PASS
TEST          3
PASS
TEST          4
FAIL
TEST          5
PASS
TEST          6
PASS
TEST          7
PASS
*****

```

```

*****
3325A
HP-IB TEST
*****

```

```

*****
TEST RESULTS:

```

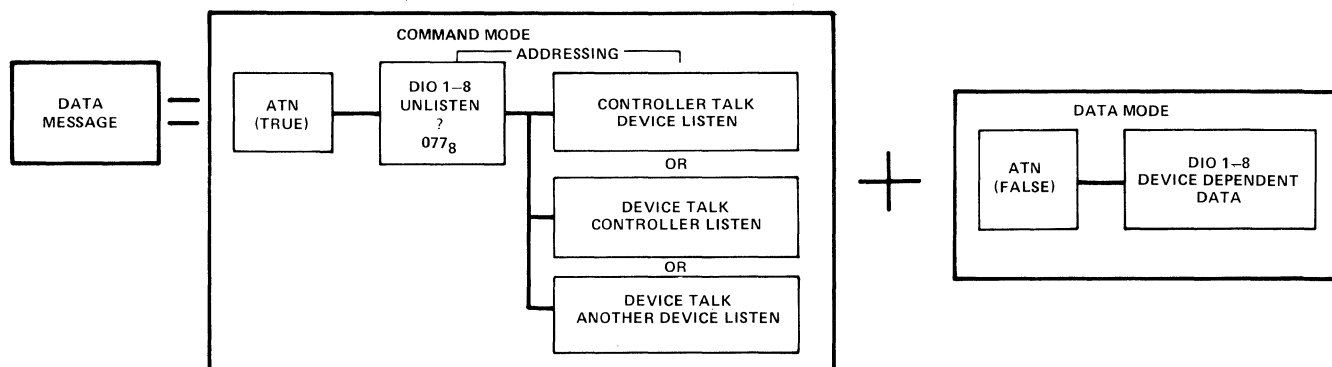
```

TEST          1
PASS
TEST          2
PASS
TEST          3
PASS
TEST          4
PASS
TEST          5
PASS
TEST          6
PASS
TEST          7
PASS
*****

```

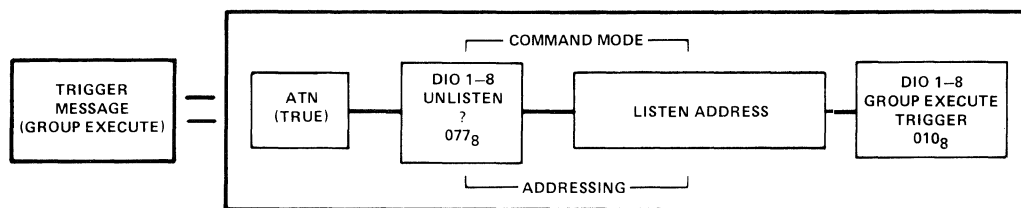
APPENDIX A SECTION III META MESSAGES BLOCK DIAGRAMMED

DATA MESSAGE — The Data message is the actual information that is sent from a talker to one or more listeners. This action requires the controller to first enter the command mode to set up the talker and listener(s) for the transfer of data. The information is then transferred in the data mode.



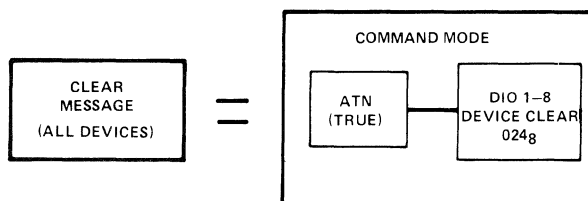
TRIGGER — The Trigger message causes all addressed instruments with this capability to execute some predefined function simultaneously.

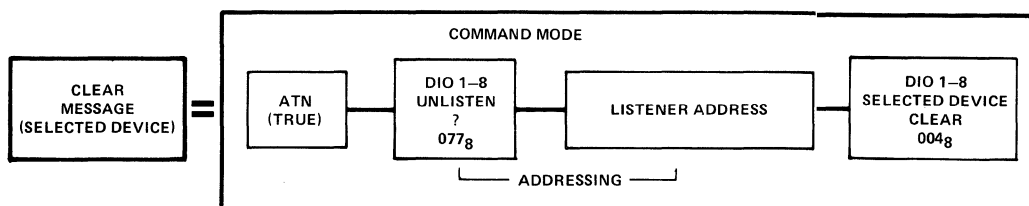
The 3325A does not have Trigger capability.



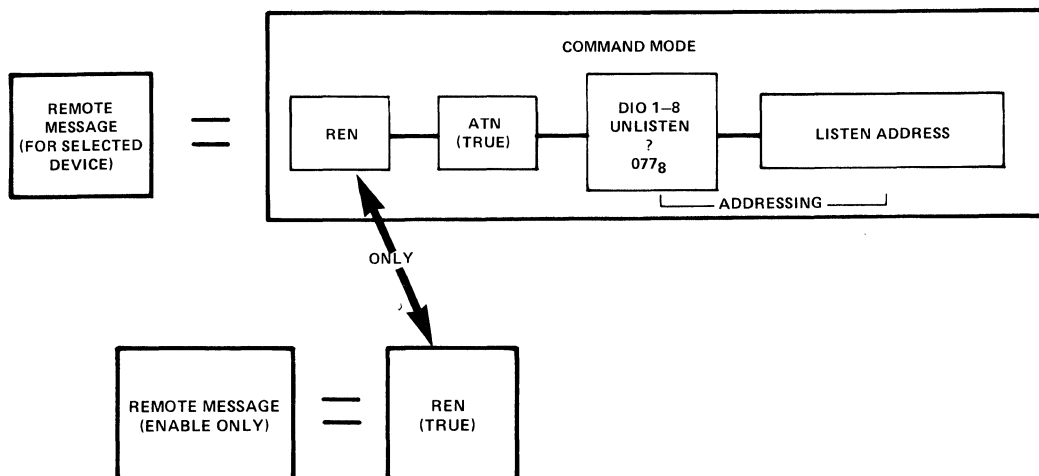
REN MUST BE TRUE BEFORE EXECUTING THE TRIGGER MESSAGE.

CLEAR — The Clear message may be implemented for addressed devices or for all devices on the bus capable of responding. In both cases the controller places the bus in the command mode to execute the message.

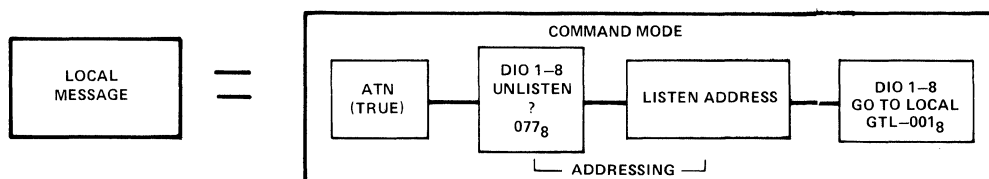




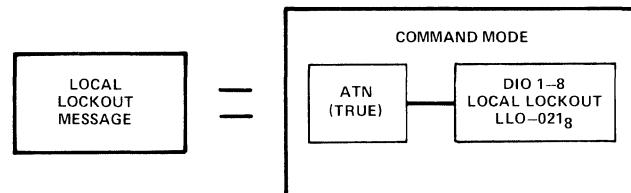
REMOTE — Only the system controller can place the device into the Remote operating condition. To implement the Remote message, the controller must set the REN line true. The HP-IB is then in the Remote Enable mode. The controller then sends the listen addresses of those devices that are to be placed in the Remote operating condition. Some instruments have been designed to enter the Remote mode as soon as REN is true.



LOCAL — The Local message will remove addressed devices from the Remote operating mode to local (front panel) control. The controller must place the HP-IB into the command mode and address to listen all devices that are to be returned to local. The Local message does not remove the HP-IB from the Remote mode, only the listening devices.

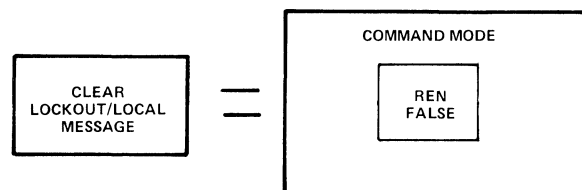


LOCAL LOCKOUT — The Local Lockout message prevents the operator from placing the instrument into local control from the front panel. The controller must be in the command mode to send the Local Lockout message.

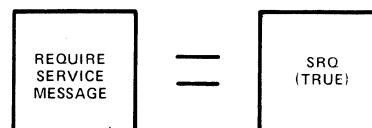


REN MUST BE TRUE BEFORE EXECUTING THE LOCAL LOCKOUT MESSAGE.

CLEAR LOCKOUT AND SET LOCAL — This message removes all devices from the Local Lockout mode and causes them to revert to local control. Because the REN line is set false, the HP-IB is in the local mode.

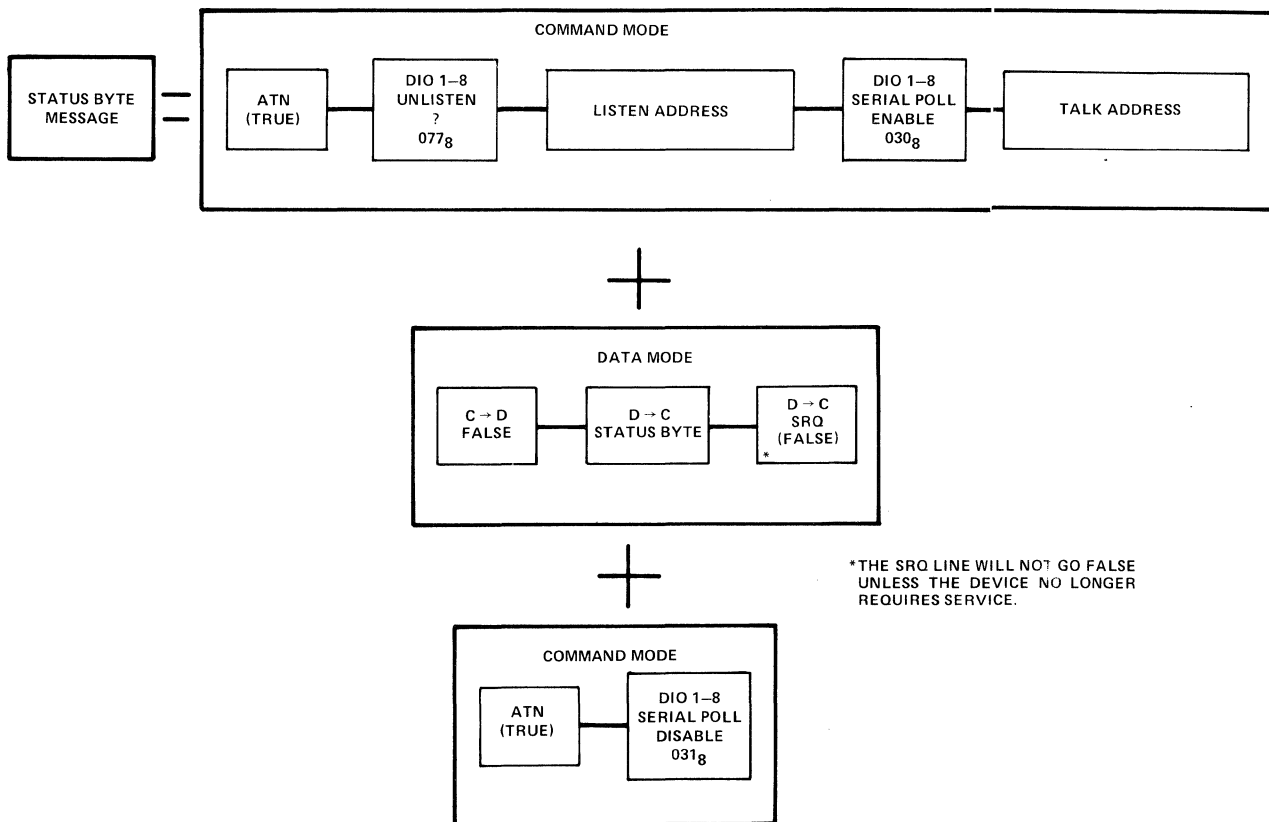


REQUIRE SERVICE — The Require Service message is implemented by a device setting the SRQ line true. The Require Service message and, therefore, the SRQ line is held true until a poll is conducted by the controller to determine the cause of the request for service, or until the device no longer needs service.

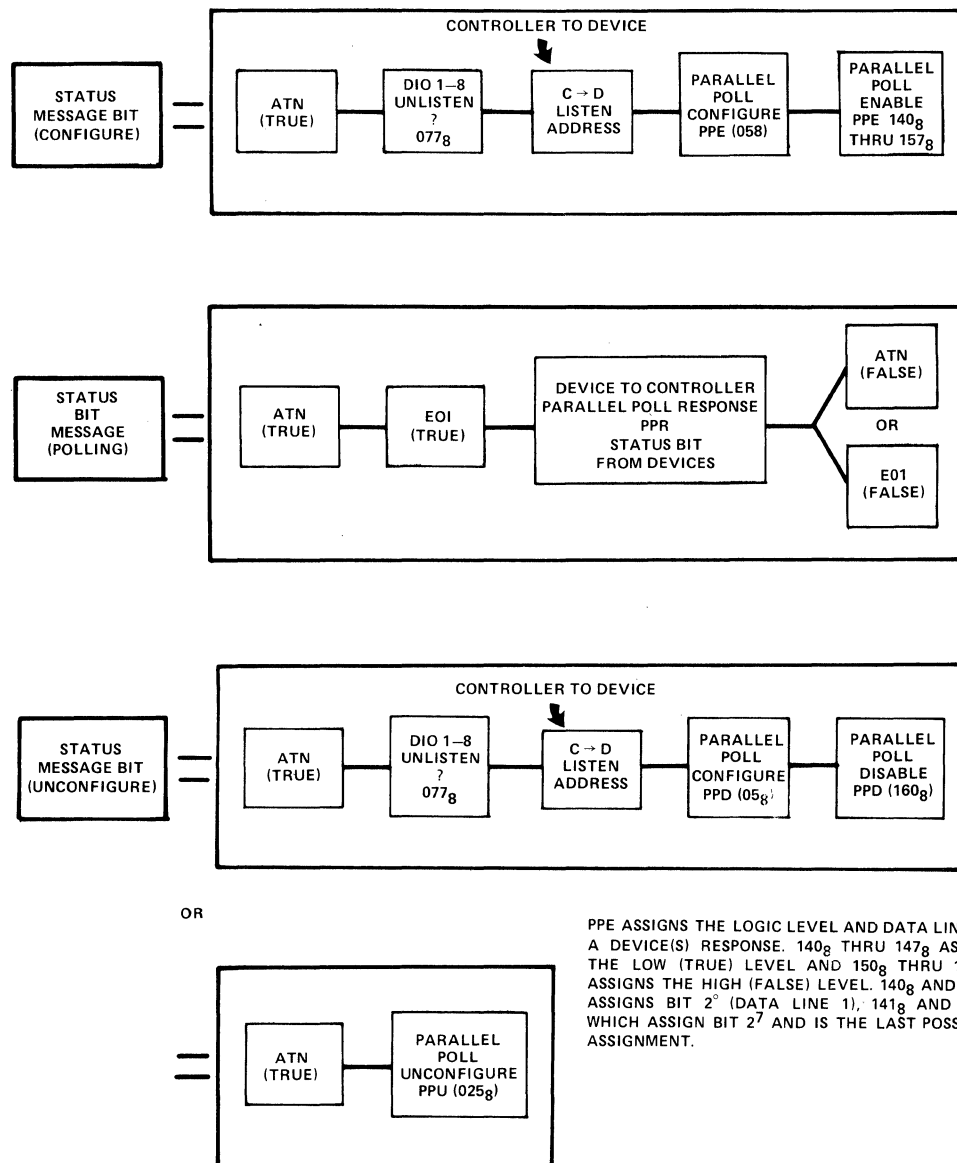


*REFER TO THE STATUS BYTE MESSAGE FOR THE SPECIFICATIONS REQUIRED TO FORCE SRQ FALSE.

STATUS BYTE — The Status Byte message represents the operational status of a single instrument during a Serial Poll. A controller usually Serial Polls devices in response to a Require Service message. The controller requests device status from one device at a time. The status information byte (8 bits) sent by the device will tell whether that device needed service and why. A device will stop requesting service upon being Serial Polled, or if it no longer needs service. The controller initiates the message by placing the bus into the command mode, sending the Serial Poll Enable command, and addressing the specific devices to be polled, one at a time. The device then sends its Status Byte and clears the SRQ line provided the cause for the require Service message is no longer present. The controller then places the bus in the command mode to terminate the message with a Serial Poll Disable command.

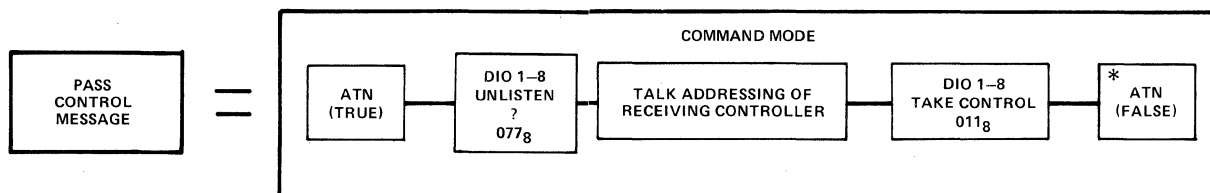


STATUS BIT — The Status Bit message is sent by a device to the controller to indicate its operational status in response to a Parallel Poll. Parallel Polling consists of the controller requesting one bit of status from each device simultaneously. The Parallel Poll may consist of three types of operations: Configuring, Polling, and Unconfiguring. In Configuring, the controller assigns each device a logic level and bit (on the bus data lines) for a poll response. During polling, each device responds on its assigned data line with the appropriate logic level. In Unconfiguring, the controller negates the bit and level assignments for all or selected devices. Several devices may be assigned to the same bit and level, causing their response bits to be logically ORed or ANDed.



The 3325A does not respond to Parallel Poll.

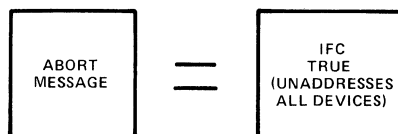
PASS CONTROL — The Pass Control message transfers bus management responsibilities from the active controller to another controller. In order to pass control, the active controller must enter the command mode, send the talk address, and the HP-IB characters for talk control.



*THE RECEIVING CONTROLLER TAKES CONTROL AT THIS TIME.

The 3325A does not respond to the Pass Control message.

ABORT —The system Controller implements the Abort Message to regain control of the HP-IB from the active controller.



APPENDIX B
SECTION III
PROGRAMMING THE MODEL 3325A
with the
MODEL 9825A CALCULATOR

The following basic examples are provided to assist the operator in developing programs for the Model 3325A in an HP-IB system which uses the -hp- Model 9825A Calculator as the system controller. The calculator must be equipped with a General I/O ROM and an HP-IB Interface set to select code 7. The calculator (controller) normally holds the REN line true, unless the "lcl 7" (local) command is sent. REN may be returned to the true state by the "rem 7" (remote) command.

Example 1: This is a basic program statement which accomplishes the following:

Address the controller to talk

Address the 3325A to listen

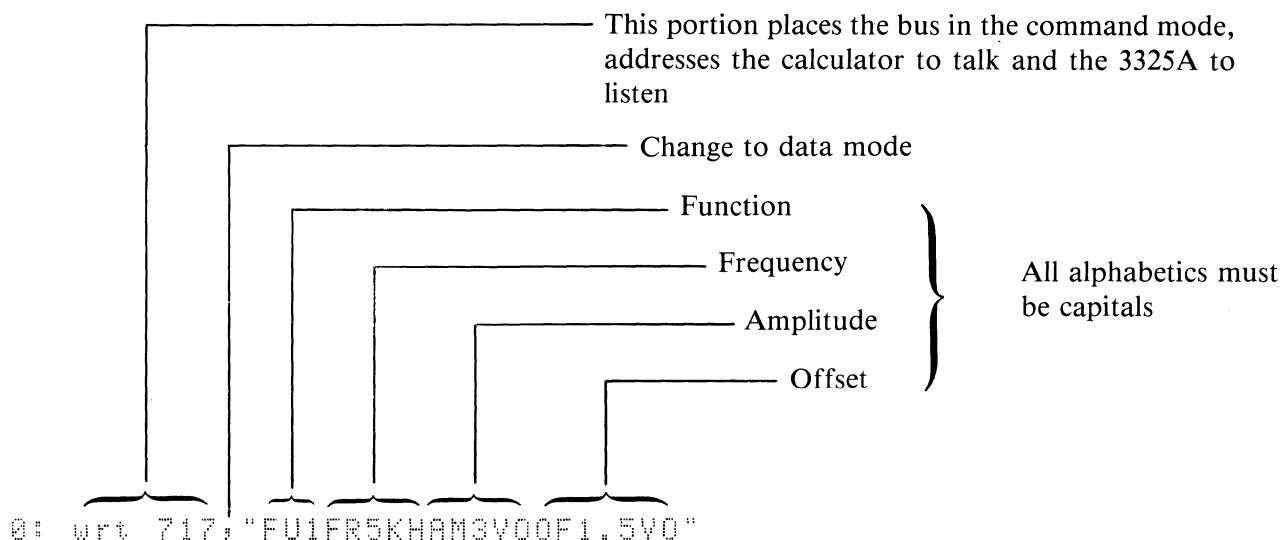
Sent Program Data:

Function: Sine

Frequency: 5 kHz

Amplitude: 3 Vp-p

Offset: +1.5 V



The last parameter programmed can be changed without sending the parameter mnemonic. For example, following the program string above, the offset (OF) may be changed to 1 V by sending "1VO".

Example: 2: This program sets up sweep parameters and initiates a single sweep.

Address the controller to talk

Address the 3325A to listen

Send Program Data:

Function: Sine

Amplitude: 3 Vrms

Start Frequency: 1 kHz

Stop Frequency: 10 kHz

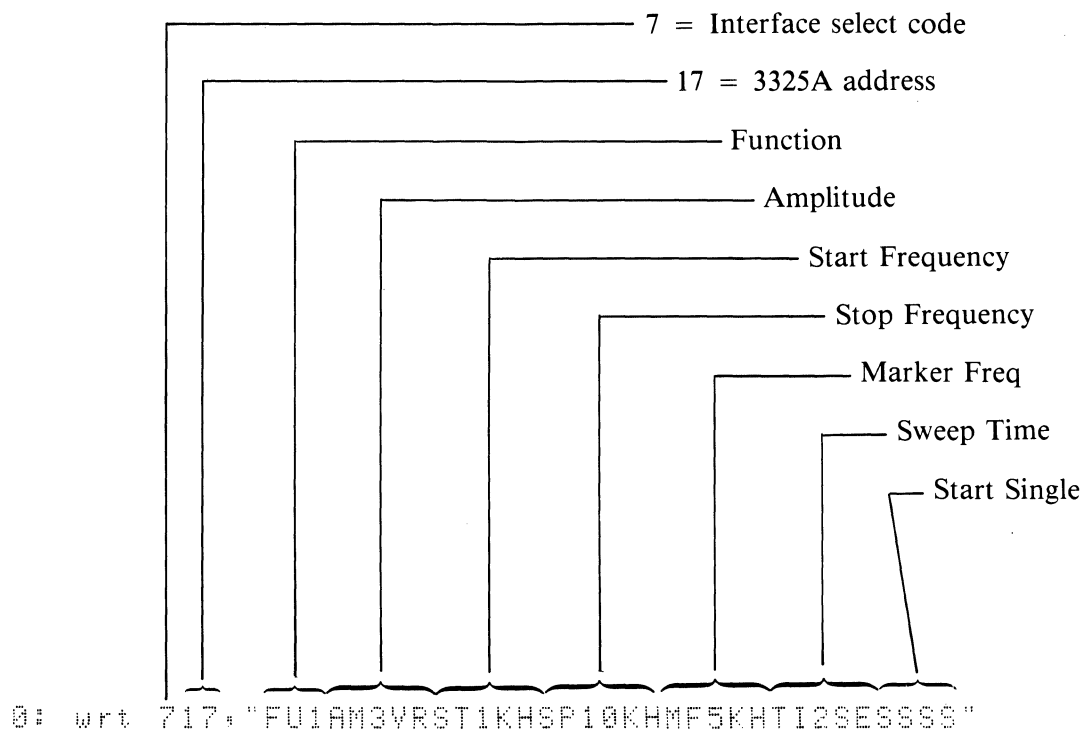
Marker Frequency: 5 kHz

Sweep Time: 2 seconds

Start Single Sweep

NOTE

To start a single sweep the mnemonic "SS" must be sent twice. The first "SS" sets the 3325A to the Start frequency, and the second "SS" starts the sweep.



Example 3: This example checks the "Require Service" status of the 3325A and if it did request service, determines the reason.

```

0: wrt 717,"MSOF
  U3AM3VOST1KHSP1
  5KHM5KHTI5SESC"
1: wait 1000
2: rds(717)→S
3: if bit(6,S)=1
  ;prt "Request
  Service";asb 5
4: dsp "PROCEED
  WITH PROGRAM";
  stop
5: if bit(0,S)=1
  ;prt "Program
  Error";wrt 717,
  "IER";red 717,E
6: if E=1;prt
  "Parameter out
  of Bounds"
7: if E=2;prt
  "Invalid Delimi
  ter"
8: if E=3;prt
  "Frea too large
  for Function"
9: if E=4;prt
  "Sweep Time
  Invalid"
10: if E=5;prt
  "Offset & Amptd
  Incompatible"
11: if E=6;prt
  "Sweep Paramete
  r Error"
12: if E=7;prt
  "Unrecognizable
  Mnemonic"
13: if E=8;prt
  "Unrecognizable
  Data Char"
14: if E=9;prt
  "Option Does
  Not Exist"
  
```

1. Enables all service request conditions.

2. Program data contains an error. Stop frequency (SP15KH) is too large for triangle function (FU3).

3. Wait statement allows time for sweep to start before reading status.

4. Read status byte from the 3325A and place in the calculator variable "S".

5 If bit 6 of the status byte = 1, the 3325A did request service. Go to subroutine to determine the reason.

6. Programming continues at this point if the 3325A did not request service or upon returning from the subroutine.

7. If service request resulted from a program string error, interrogate the 3325A to determine the error code and place in the calculator variable "E".

8. Determine the nature of the program error.

```

15: if bit(1,
    S)=1:prt "Sweep
    Stopped"
16: if bit(2,
    S)=1:prt "Sweep
    Started"
17: if bit(3,
    S)=1:prt "Syste
    m Failure"
18: if bit(5,
    S)=1:prt "Sweep
    ing"
19: if bit(7,
    S)=1:prt "Busy"
20: ret

```

Diagram showing flow from line 17 to line 9, and from line 20 to line 10.

9. Determine other reason for service request and if "Sweeping" or "Busy" flags were true.

10. Return from subroutine.

11. Printer records the results of the serial poll.

12. If the program string were corrected to make all data valid, this printout would result from the above program.

```

Request Service
Program Error
Sweep Parameter
Error

```

```

Request Service
Sweep Started
Sweeping

```

Example 4: The 3325A can be set up manually to the optimum parameters needed for the test to be performed, then the calculator can interrogate the 3325A to determine and record these parameters. This example program interrogates:

Function: IFU
 Frequency: IFR
 Amplitude: IAM
 DC Offset: IOF

```

0: wrt 717,"IFU"
  :red 717,Wifxd
  6
1: prt "Function
  =" ,W

```

Line 0 Write statement interrogates Function; read statement addresses 3325A to talk, calculator to listen, and places data in variable W; "fxd 6" fixes six decimal places.

Line 1 Because only numerical data can be placed in the variables, print statements may include in quotes the parameter interrogated.

```

2: wrt 717,"IFR"
   ;red 717,F
3: prt "Frequenc
   y =",F,"Hz"
4: wrt 717,"IAM"
   ;red 717,A
5: prt "Amplitud
   e =",A
6: wrt 717,"IOF"
   ;red 717,0
7: prt "Offset
   =",0,"V"

```

Lines 2 - 7 Other parameters are interrogated. Amplitude data acquired by this program does not indicate the units programmed. Frequency is always returned in Hz and DC Offset in Volts.

```

Function =
      1.000000
Frequency =
      1000.000000
Hz
Amplitude =
      22.310000
Offset =
      0.001000
V

```

— This printout results from the above program.

If the calculator is equipped with a String Variable ROM, the interrogate program may be changed to the following. Because string variables accept both alpha and numeric characters, the resulting printout includes the mnemonics and delimiters (units).

```

0: dim W$(50),
   F$(50),A$(50),
   O$(50)
1: wrt 717,"IFU"
   ;red 717,W$;
   prt W$
2: wrt 717,"IFR"
   ;red 717,F$;
   prt F$
3: wrt 717,"IAM"
   ;red 717,A$;
   prt A$
4: wrt 717,"IOF"
   ;red 717,O$;
   prt O$

```

```

FU1
FR000001000.000HZ
AM000000022.310DE
OF000000.001000VO

```

1. Dimension a string variable for each parameter you want to interrogate. The dimension number (in brackets) is the number of spaces assigned to the variable.

2. This printout results when string variables are used.

Example 5: The 3325A can be made to sweep amplitude (in steps) if a for/next statement is used in the calculator program. It is recommended that the upper and lower amplitude limits selected be on the same range because irregularities in the sweep will occur if the attenuator relays are switched.

```
0: wrt 717,"FU1F
  R1KH0F0V0AM3V0"
1: for I=3 to
  10 by .1:wrt
  717:I,"V0"
2: next I
3: for I=10 to
  3 by -.1:wrt
  717:I,"V0"
4: next I
5: goto 1
```

Line 0 DC Offset (OF0VO) is programmed to zero because any offset would be incompatible with the 10 V maximum amplitude of this sweep.

Line 1 The sweep limits (3 to 10) are on the same range. The sweep increment is in .1 V steps. Because amplitude was the last parameter programmed, the write statement does not require the "AM" mnemonic.

Line 2 The calculator returns to Line 1 until I = 10, then proceeds to Line 3.

Line 3 The sweep decrement is also in .1 V steps.

Line 5 Return to Line 1 to continue sweeping.

The sweep speed is determined by calculator and 3325A data transfer and processing times. If a slower sweep time is desired, wait statements may be added before the "next I" statements.

MODEL 3325A
SYNTHESIZER/FUNCTION GENERATOR
HP-IB PROGRAMMING CODE
(ASCII Characters)

<u>F</u> unction			<u>H</u> igh <u>V</u> oltage Output	
DC only	0		On	1
Sine	1		Off	0
Square	2			
Triangle	3		Amplitude Modulation – <u>MA</u>	
Positive Ramp	4		On	1
Negative Ramp	5		Off	0
<u>F</u> requency			Phase Modulation – <u>MP</u>	
Hz	HZ		On	1
kHz	KH		Off	0
MHz	MH			
<u>A</u> mplitude			<u>D</u> ata	
Volts p-p	VO		0	0
mVp-p	MV		1	1
Vrms	VR		2	2
mVrms	MR		3	3
dBm	DB		4	4
			5	5
			6	6
DC <u>O</u> ffset			7	7
Volts	VO		8	8
mV	MV		9	9
			–	–
<u>P</u> Hase			.(Decimal)	.
Degrees	DE			
Sweep <u>S</u> tart Frequency			Interrogate Operations	
Sweep <u>S</u> to <u>P</u> Frequency			Function	IFU
Sweep <u>M</u> arker Frequency			Frequency	IFR
			Amplitude	IAM
			Offset	IOF
			Phase	IPH
Sweep <u>T</u> ime			Swp Start Freq	IST
Seconds	SE		Swp Stop Freq	ISP
			Swp Mkr Freq	IMF
<u>S</u> weep Mode			Sweep Time	ITI
Linear	1		Sweep Mode	ISM
Logarithmic	2		Rear/Front Out	IRF
			High Volt Out	IHV
<u>S</u> to <u>R</u> e Program			Error	IER
	0 – 9		Program Mode	IMD
<u>R</u> Ecall Program			Amptd Mode	IMA
	0 – 9		Phase Mode	IMP
<u>R</u> ear or <u>F</u> ront Panel Output			Error Codes (See Paragraph 3-146)	
Front	1		1. Entry parameter out of bounds	
Rear	2		2. Invalid delimiter	
Execution Functions			3. Frequency too large for function	
Assign Zero <u>P</u> hase			4. Sweep time too small or too large	
Perform <u>A</u> mp <u>t</u> d <u>C</u> al			5. Offset and amplitude incompatible	
<u>S</u> tart <u>S</u> ingle*			6. Sweep frequency or bandwidth error	
<u>S</u> tart <u>C</u> ontinuous			7. Unrecognizable mnemonic	
Perform Self <u>T</u> est			8. Unrecognizable data character	
			9. Option does not exist	

*Start Single code must be sent twice “SSSS”. The first “SS” resets the sweep to start conditions and the second “SS” starts the sweep.

HP-IB IMPLEMENTATION WORKSHEET

DEVICE IDENTIFICATION													
ADDRESS	LISTEN												
	TALK												
	DECIMAL												
MESSAGE	DEVICE IMPLEMENTATION*												
DATA													
TRIGGER													
CLEAR													
LOCAL													
REMOTE													
LOCAL LOCKOUT													
CLEAR LOCKOUT AND SET LOCAL													
REQUIRE SERVICE													
STATUS BYTE													
STATUS BIT													
PASS CONTROL													
ABORT													

*S=SEND ONLY R=RECEIVE ONLY SR=SEND AND RECEIVE N=NOT IMPLEMENTED

OPERATIONAL VERIFICATION RECORD

Hewlett-Packard
Model 3325A
Synthesizer/Function Generator
Serial No. _____

Tested by _____

Date _____

Par. 4-10 Self Test Passed _____

Par. 4-12 Sine Wave Verification

Step d 20 MHz: Frequency and Amplitude Passed _____

Step g Signal Purity Passed _____

High Voltage Output (1 MHz) Passed _____

Par. 4-14 Square Wave Verification

Step c Frequency and Amplitude Passed _____

Step d Rise Time Passed _____

Step e Overshoot Passed _____

Par. 4-16 Triangle and Ramp Verification

Step c Triangle Freq. and Amptd. Passed _____

Step d + Ramp Freq. and Amptd. Passed _____

Step e – Ramp Freq. and Amptd. Passed _____

Step f – Ramp Retrace Time Passed _____

Step g + Ramp Retrace Time Passed _____

Step i Triangle Linearity Passed _____

Par. 4-18 Amplitude Flatness Passed _____

Spec

Par. 4-20 Sync Output Check High _____ > +1.2 V

Low _____ < 0.2 V

Par. 4-22 Frequency Accuracy Spec.

Step c Sine, 20 MHz _____ ± 100 Hz

Step d Square, 10 MHz _____ ± 50 Hz

Step e Triangle, 10 kHz (100,000 ns) _____ ± .5 ns

Step f Ramp, 10 kHz (100,000 ns) _____ ± .5 ns

Operational Verification

Par. 4-24 Output Level and Attenuator Check
(DC Offset Only)

Entry	Min.	Max.
- 5 V	- 4.980 V _____	- 5.020 V
(+) 5 V	+ 4.980 V _____	+ 5.020 V
1.499 V	+ 1.49300 V _____	+ 1.50499 V
499.9 mV	+ 0.49790 V _____	+ 0.50190 V
149.9 mV	+ 0.14930 V _____	+ 0.15050 V
49.99 mV	+ 0.04979 V _____	+ 0.05019 V
14.99 mV	+ 0.01493 V _____	+ 0.01505 V
4.999 mV	+ 0.04979 V _____	+ 0.005019 V
1.499 mV	+ 0.001479 V _____	+ 0.001519 V

High Voltage Output (Option 002)

20 V	+ 19.775 V _____	+ 20.225 V
- 20 V	- 19.775 V _____	- 20.225 V

Par. 4-26 Harmonic Distortion

All Harmonics Below:

20 MHz	_____ - 25 dB
15 MHz	_____ - 30 dB
2 MHz	_____ - 40 dB
200 kHz	_____ - 60 dB
50 kHz	_____ - 65 dB
10 kHz	_____ - 65 dB
1 kHz	_____ - 65 dB
100 Hz	_____ - 65 dB

High Voltage Output (Option 002)

100 Hz	_____ - 65 dB
10 kHz	_____ - 65 dB
200 kHz	_____ - 60 dB
1 MHz	_____ - 40 dB

Par. 4-28 Close-In Spurious Signal Test Passed _____

Par. 4-30 HP-IB Check Passed _____

PERFORMANCE TEST RECORD

Hewlett-Packard
Model 3325A
Synthesizer/Function Generator
Serial No. _____

Tested By _____

Date _____

Par. 4-37 Harmonic Distortion

Fundamental Frequency	Specification
20 MHz	_____ – 25 dB
15 MHz	_____ – 30 dB
2 MHz	_____ – 40 dB
200 kHz	_____ – 60 dB
50 kHz	_____ – 65 dB
10 kHz	_____ – 65 dB
1 kHz	_____ – 65 dB
100 Hz	_____ – 65 dB
High Voltage Output (Option 002)	
100 Hz	_____ – 65 dB
10 kHz	_____ – 65 dB
200 kHz	_____ – 60 dB
1 MHz	_____ – 40 dB

Par. 4-39 Spurious Signal Tests

Mixer Spurious Test	_____ – 70 dB
Close-in Spurious Test	
5 MHz	_____ – 70 dB
10 MHz	_____ – 70 dB
15 MHz	_____ – 70 dB
20 MHz	_____ – 70 dB

Par. 4-41 Integrated Phase Noise

19.901 MHz	_____ – 60 dB
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Par. 4-43 Amplitude Modulation Envelope Distortion

_____	– 30 dB
-------	---------

Par. 4-45 Square Wave

Rise Time	_____ < 20 ns
Fall Time	_____ < 20 ns
Overshoot, Positive Peak	_____ < 500 mV
Overshoot, Negative Peak	_____ < 500 mV

Par. 4-47 Ramp Retrace Time

+ Ramp _____ $< 3 \mu s$

- Ramp _____ $< 3 \mu s$

Par. 4-49 Sync Output

V_{high} _____ $> +1.2 V$

V_{low} _____ $< +0.2 V$

Par. 4-51 Square Wave Symmetry _____ $> 3.2 ns$

Par. 4-53 Frequency Accuracy

Sine, 20 MHz _____ $\pm 100 Hz$

Square, 10 MHz _____ $\pm 50 Hz$

Triangle, 10 kHz (100,000 ns) _____ $\pm .5 ns$

Ramp, 10 kHz (100,000 ns) _____ $\pm .5 ns$

Par. 4-55 Phase Increment Accuracy

	Minimum	Time Difference	Maximum
Zero Phase Time Interval _____			
1° Increment Time Interval _____	22.22 ns	_____	33.34 ns
10° Increment Time Interval _____	272.22 ns	_____	283.34 ns
100° Increment Time Interval _____	2772.22 ns	_____	2783.34 ns

Par. 4-57 Phase Modulation Linearity

DVM Reading	Phase Difference	Cumulative Phase	x times y	x^2
x_1 _____	1 0 _____	y_1 0 _____	0 _____	_____
x_2 _____	2 _____	y_2 _____	_____	_____
x_3 _____	3 _____	y_3 _____	_____	_____
x_4 _____	4 _____	y_4 _____	_____	_____
x_5 _____	5 _____	y_5 _____	_____	_____
x_6 _____	6 _____	y_6 _____	_____	_____
x_7 _____	7 _____	y_7 _____	_____	_____
x_8 _____	8 _____	y_8 _____	_____	_____
x_9 _____	9 _____	y_9 _____	_____	_____
x_{10} _____	10 _____	y_{10} _____	_____	_____
x_{11} _____	11 _____	y_{11} _____	_____	_____
Σx _____		Σy _____	Σxy _____	Σx^2 _____
$(\Sigma x)^2$ _____		$\Sigma x \Sigma y$ _____		

Best Fit Straight Line Phase	Minimum Limit	Measured Cumulative Phase	Maximum Limit
(y ₁) _____	_____	y ₁ 0 _____	_____
(y ₂) _____	_____	y ₂ _____	_____
(y ₃) _____	_____	y ₃ _____	_____
(y ₄) _____	_____	y ₄ _____	_____
(y ₅) _____	_____	y ₅ _____	_____
(y ₆) _____	_____	y ₆ _____	_____
(y ₇) _____	_____	y ₇ _____	_____
(y ₈) _____	_____	y ₈ _____	_____
(y ₉) _____	_____	y ₉ _____	_____
(y ₁₀) _____	_____	y ₁₀ _____	_____
(y ₁₁) _____	_____	y ₁₁ _____	_____

Specification: $\pm 0.5\%$ of (y₁₁) = $\pm$ _____ °

Par 4-59

Amplitude Accuracy

Entry	Minimum	Measured	Maximum
Sine Wave Test			
Amplitude: 3.536 Vrms			
Sine, 100 Hz	3.495 V	_____	3.577 V
Sine, 1 kHz	3.495 V	_____	3.577 V
Sine, 100 kHz	3.495 V	_____	3.577 V
Amplitude: 1.061 Vrms			
Sine, 100 Hz	1.048 V	_____	1.073 V
Sine, 1 kHz	1.048 V	_____	1.073 V
Sine, 100 kHz	1.048 V	_____	1.073 V
Amplitude: 0.3536 Vrms			
DC, 1 mV			
Sine, 100 Hz	0.3411 V	_____	0.3660 V
Sine, 1 kHz	0.3411 V	_____	0.3660 V
Sine, 100 Hz	0.3411 V	_____	0.3660 V
Function Test			
Amplitude: 10 Vpp			
Square, 99.9 Hz	3.661V	_____	3.735V
Triangle, 99.9 Hz	3.643V	_____	3.754V
Pos Ramp, 99.9 Hz	3.643V	_____	3.754V
Neg Ramp, 99.9 Hz	3.643V	_____	3.754V
Square, 1 kHz	3.661V	_____	3.735V

Triangle, 2 kHz	3.643V	_____	3.754V
Pos Ramp, 500 Hz	3.643V	_____	3.754V
Neg Ramp, 500 Hz	3.643V	_____	3.754V
Square, 100 kHz	3.661V	_____	3.735V
Triangle, 10 kHz	3.513V	_____	3.883V
Pos Ramp, 10 kHz	3.328V	_____	3.996V
Neg Ramp, 10 kHz	3.328V	_____	3.996V

Amplitude: 3 Vpp

Square, 99.9 Hz	2.970 V	_____	3.030 V
Triangle, 99.9 Hz	2.955 V	_____	3.045 V
Pos Ramp, 99.9 Hz	2.955 V	_____	3.045 V
Neg Ramp, 99.9 Hz	2.955 V	_____	3.045 V
Square, 1 kHz	2.970 V	_____	3.030 V
Triangle, 2 kHz	2.955 V	_____	3.045 V
Pos Ramp, 500 Hz	2.955 V	_____	3.045 V
Neg Ramp, 500 Hz	2.955 V	_____	3.045 V
Square, 100 kHz	2.970 V	_____	3.030 V
Triangle, 10 kHz	2.850 V	_____	3.150 V
Pos Ramp, 10 kHz	2.700 V	_____	3.300 V
Neg Ramp, 10 kHz	2.700 V	_____	3.300 V

Amplitude: 1 Vpp

DC: 1 mV

Square, 99.9 Hz	0.970 V	_____	1.030 V
Triangle, 99.9 Hz	0.960 V	_____	1.040 V
Pos Ramp, 99.9 Hz	0.960 V	_____	1.040 V
Neg Ramp, 99.9 Hz	0.960 V	_____	1.040 V
Square, 1 kHz	0.970 V	_____	1.030 V
Triangle, 2 kHz	0.960 V	_____	1.040 V
Pos Ramp, 500 Hz	0.960 V	_____	1.040 V
Neg Ramp, 500 Hz	0.960 V	_____	1.040 V
Square, 100 kHz	0.970 V	_____	1.030 V
Triangle, 10 kHz	0.940 V	_____	1.060 V
Pos Ramp, 10 kHz	0.890 V	_____	1.110 V
Neg Ramp, 10 kHz	0.890 V	_____	1.110 V

High Voltage (Option 002) Sinewave Test

Amplitude: 14.14 Vrms

Sine, 2 kHz	13.86 V	_____	14.42 V
-------------	---------	-------	---------

High Voltage (Option 002) Function Test

Amplitude: 40 Vpp

Square, 2 kHz	3.466V	_____	3.607V
Triangle, 2 kHz	3.466V	_____	3.607V
Pos Ramp, 2 kHz	3.466V	_____	3.607V
Neg Ramp, 2 kHz	3.466V	_____	3.607V

Amplitude Flatness

Sine, 3 Vpp, 1 kHz
(Reference)

= Y

Allowable tolerance
($\pm 6.6\%$)

(0.934Y)

(1.066Y)

2.001 MHz

4.001 MHz

6.001 MHz

8.001 MHz

10.001 MHz

12.001 MHz

14.001 MHz

16.001 MHz

18.001 MHz

20.001 MHz

Sine, 10 Vpp, 1 kHz
(Reference)

= Y

Allowable tolerance
($\pm 6.3\%$)

(0.937Y)

(1.063Y)

2.001 MHz

4.001 MHz

6.001 MHz

8.001 MHz

10.001 MHz

12.001 MHz

14.001 MHz

16.001 MHz

18.001 MHz

20.001 MHz

Square, 10 Vpp,

Pass

(check one)

Fail

High Voltage (Option 002) Flatness

Sine, 40 Vpp,

Pass

(check one)

Fail

Par. 4-61

DC Offset Accuracy (DC Only)

Entry	Minimum	Maximum
5 V	+ 4.980 V	+ 5.020 V
- 5 V	- 4.980 V	- 5.020 V
- 1.499 V	- 1.49300 V	- 1.50499 V
1.499 V	+ 1.49300 V	+ 1.50499 V
499.9 mV	+ 0.49790 V	0.50190 V
- 499.9 mV	- 0.49790 V	- 0.50190 V
- 149.9 mV	- 0.14930 V	- 0.15050 V
149.9 mV	+ 0.14930 V	+ 0.15050 V
49.99 mV	+ 0.04979 V	+ 0.05019 V
- 49.9 mV	- 0.04979 V	- 0.05019 V
- 14.99 mV	- 0.01493 V	- 0.01505 V
14.99 mV	+ 0.01493 V	+ 0.01505 V
4.999 mV	+ 0.004979 V	+ 0.005019 V
- 4.999 mV	- 0.004979 V	- 0.005019 V
- 1.499 mV	- 0.001479 V	- 0.001519 V
1.499 mV	+ 0.001479 V	+ 0.001519 V

High Voltage Output Option 002

20 V	+ 19.775 V	+ 20.225 V
- 20 V	- 19.775 V	- 20.225 V

Par. 4-63

DC Offset Accuracy with AC Functions

Sine 20.999 999 999 MHz	Minimum	Maximum
4.5 V	+ 4.350 V	+ 4.650 V
- 4.5 V	- 4.350 V	- 4.650 V
Sine 999.9 kHz		
- 4.5 V	- 4.440 V	- 4.560 V
4.5 V	+ 4.440 V	+ 4.560 V
Square 999.9 kHz		
4.5 V	+ 4.440 V	+ 4.560 V
- 4.5 V	- 4.440 V	- 4.560 V
Square 9.9999 MHz		
- 4.5 V	- 4.350 V	- 4.650 V

Triangle 9.9 kHz

– 4.5 V

– 4.440 V _____ – 4.560 V

Ramp 9.9 kHz

– 4.5 V

– 4.380 V _____ – 4.620 V

Par. 4-65. Triangle Linearity

x Values	Positive Slope Measurement	x times y	Calculated Best Fit Straight Line	Tolerances	
				Minimum	Maximum
$x_1 = 1$	(10%) y_1 _____	_____	(y_1) _____	_____	_____
$x_2 = 2$	(20%) y_2 _____	_____	(y_2) _____	_____	_____
$x_3 = 3$	(30%) y_3 _____	_____	(y_3) _____	_____	_____
$x_4 = 4$	(40%) y_4 _____	_____	(y_4) _____	_____	_____
$x_5 = 5$	(50%) y_5 _____	_____	(y_5) _____	_____	_____
$x_6 = 6$	(60%) y_6 _____	_____	(y_6) _____	_____	_____
$x_7 = 7$	(70%) y_7 _____	_____	(y_7) _____	_____	_____
$x_8 = 8$	(80%) y_8 _____	_____	(y_8) _____	_____	_____
$x_9 = 9$	(90%) y_9 _____	_____	(y_9) _____	_____	_____
$\Sigma x = 45$	Σy _____	Σxy _____			
$(\Sigma x)^2 = 2025$	$\Sigma x \Sigma y$ _____				
$\Sigma x^2 = 285$					

Par. 4-65. Triangle Linearity (Con'd)

Par. 4-65. Triangle Linearity

x Values	Positive Slope Measurement	x times y	Calculated Best Fit Straight Line	Tolerances	
				Minimum	Maximum
$x_9 = 9$	(90%) y_9 _____	_____	(y_9) _____	_____	_____
$x_8 = 8$	(80%) y_8 _____	_____	(y_8) _____	_____	_____
$x_7 = 7$	(70%) y_7 _____	_____	(y_7) _____	_____	_____
$x_6 = 6$	(60%) y_6 _____	_____	(y_6) _____	_____	_____
$x_5 = 5$	(50%) y_5 _____	_____	(y_5) _____	_____	_____
$x_4 = 4$	(40%) y_4 _____	_____	(y_4) _____	_____	_____
$x_3 = 3$	(30%) y_3 _____	_____	(y_3) _____	_____	_____
$x_2 = 2$	(20%) y_2 _____	_____	(y_2) _____	_____	_____
$x_1 = 1$	(10%) y_1 _____	_____	(y_1) _____	_____	_____
$\Sigma z = 45$	Σy _____	Σxy _____			
$(\Sigma x)^2 = 2025$	$\Sigma x \Sigma y$ _____				
$\Sigma x^2 = 285$					

Par. 4-67. x Drive Linearity

x Values	Positive Slope Measurement	x times y	Calculated Best Fit Straight Line	Tolerances	
				Minimum	Maximum
$x_1 = 1$	(10%) y_1 _____	_____	(y_1) _____	_____	_____
$x_2 = 2$	(20%) y_2 _____	_____	(y_2) _____	_____	_____
$x_3 = 3$	(30%) y_3 _____	_____	(y_3) _____	_____	_____
$x_4 = 4$	(40%) y_4 _____	_____	(y_4) _____	_____	_____
$x_5 = 5$	(50%) y_5 _____	_____	(y_5) _____	_____	_____
$x_6 = 6$	(60%) y_6 _____	_____	(y_6) _____	_____	_____
$x_7 = 7$	(70%) y_7 _____	_____	(y_7) _____	_____	_____
$x_8 = 8$	(80%) y_8 _____	_____	(y_8) _____	_____	_____
$x_9 = 9$	(90%) y_9 _____	_____	(y_9) _____	_____	_____
$\Sigma x = 45$	Σy _____	Σxy _____			
$(\Sigma x)^2 = 2025$	$\Sigma x \Sigma y$ _____				
$\Sigma x^2 = 285$					

Par. 4-69 Ramp Period Variation

Negative Slope Ramp, 100 Hz	_____ < $\pm 100 \mu s$
Positive Slope Ramp, 100 Hz	_____ < $\pm 100 \mu s$
Positive Slope Ramp, 99.9 Hz	_____ < $\pm 100 \mu s$

Par. 4-71. HP-IB Interface

	Pass	Fail	or Attach Calculator Tape
Test 1	_____	_____	
Test 2	_____	_____	
Test 3	_____	_____	
Test 4	_____	_____	
Test 5	_____	_____	
Test 6	_____	_____	
Test 7	_____	_____	

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BOGOTA 1 D.E.
Tel: 269-8877
 Telex: 44400
 Cable: AARIS Bogota
 A, E, M, P
Instrumentacion
H.A. Langebaek & Kier S.A.
Edif. Camacol, Local 105
Carrera 63 NO. 49-A-31
Apartado 54098
MEDELLIN
Tel: 304475
 A, E, M, P

COSTA RICA

Cientifica Costarricense S.A.
Avenida 2, Calle 5
San Pedro de Montes de Oca
Apartado 10159
SAN JOSE
Tel: 24-38-20, 24-08-19
Telex: 2367 GALGUR CR
 Cable: GALGUR
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CYPRUS

Kryponics
19 Gregorios Xenopoulos Street
P.O. Box 1152
NICOSIA
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 E, M, P

CZECHOSLOVAKIA

Vyojova a Provozni Zakladna
Vyzkumnych Ustavu v Bechovicich
CSSR-25097 BECHOVICE U PRAHY
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Telex: 12133
 P*

Hewlett-Packard
Obchodni Zastupitelstvi v CSSR
Pisemny stylk
Post. schranka 27
CS 118 01 PRAHA 011
Tel: 66-296
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 A*, C*, E*, M*, P*

DENMARK

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DK-8600 SILKEBORG
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 Telex: 37409 hpas dk
 CM, CS, E

ECUADOR

CYEDE Cia. Ltda.
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Avenida Eloy Alfaro 1749
QUITO
Tel: 450-975, 243-052
Telex: 2548 CYEDE ED
 Cable: CYEDE-Quito
 A, E, P
Hospitalar S.A.
Casilla 3590
Robles 625
QUITO
Tel: 545-250, 545-122
 Cable: HOSPITALAR-Quito
 M

EGYPT

Samitro
Sami Amin Trading Office
18 Abdel Aziz Gawish
ABDINE-CAIRO
Tel: 24-932
 P
International Engineering Associates
24 Hussein Hegazi Street
Kasr-el-Aini
CAIRO
Tel: 23-829
Telex: 93830
 E, M



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Arranged alphabetically by country

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IPESA
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Edificio Sarah 1148
SAN SALVADOR
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A*,C,E,M,P

ETHIOPIA

Abdella Abdulmalik
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ADDIS ABABA
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A,E,M

FINLAND

Hewlett-Packard Oy
Revontulentie 7
SF-02100 **ESPOO** 10
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A,CM,CP,E,MS,P

FRANCE

Hewlett-Packard France
Le Ligoures
Bureau de Vente de
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F-13090 **AIX-EN-PROVENCE**
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Hewlett-Packard France
Bureau de Vente de Lyon
Chemin des Mouilles
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F-69130 **ECULLY** Cedex
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Telex: 310617F
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Hewlett-Packard France
Immeuble France Evry
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Boulevard de France
F-91035 **EVRY** Cedex
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Telex: 692315F
CM,E

Hewlett-Packard France
Batiment Ampere
Rue de la Commune de Paris
Boite Postale 300
F-95153 **LE BLANC MESNIL**
Tel: (01) 865-44-52
Telex: 211032F
CM,CP,E,MS

Hewlett-Packard France
Avenue du President JF Kennedy
F-33700 **MERIGNAC**
Tel: (56) 34-00-84
Telex: 550105F
CM,CP,E,MS

Hewlett-Packard France
32 Rue Lothaire
F-57000 **METZ**
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CM,CS

Hewlett-Packard France
Avenue des Tropiques
Zone d'activites de Courtaboeuf
Boite Postale 6
F-91401 **ORSAY** Cedex
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Telex: 600048F
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Hewlett-Packard France
15 Boulevard De L'Amiral Bruix
F-75016 **PARIS**
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Hewlett-Packard France
2 Allee de la Bourgonette
F-35100 **RENNES**
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Hewlett-Packard France
4 Rue Thomas Mann
F-67033 **STRASSBOURG** Cedex
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31081 **TOULOUSE** Cedex
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Telex: 531639F
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Hewlett-Packard France
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F-59650 **VILLENEUVE D'ASQ**
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Technisches Buro Boblingen
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Technisches Buro Dusseldorf
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D-6000 **FRANKFURT** 56
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"Plaiso"
G. Gerados
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Telex: 21 9492
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TAMUNING 96911
Tel: 6464513
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Telex: 36678 HEWPA HX
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Schmidt & Co. (Hong Kong) Ltd.
Wing On Centre, 28th Floor
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ICELAND

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IS-REYKJAVIK
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M

INDIA

Blue Star Ltd.
Bhavdeep
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Telex: 012-234
Cable: BLUEFROST
E

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Cable: BLUESTAR
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Blue Star Ltd.
Band Box House
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Cable: BLUESTAR
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Blue Star Ltd.
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Telex: 011-4093
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Cable: BLUESTAR
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Blue Star Ltd.
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Road
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Telex: 085-514
Cable: BLUESTAR
A*

Blue Star Ltd.
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Tel: 82057
Telex: 041-379
Cable: BLUESTAR
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Blue Star Ltd.
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Telex: 031-2463
Cable: BLUESTAR
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Blue Star Ltd.
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SECUNDERABAD 500 033
Tel: 70126
Telex: 0155-459
Cable: BLUESTAR
A,E

Blue Star Ltd.
T.C. 7/603 Poornima
Maruthankuzhi
TRIVANDRUM 695 013
Tel: 65799
Telex: 0884-259
Cable: BLUESTAR
E

SALES & SUPPORT OFFICES

Arranged alphabetically by country

3



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P.O. Box 496/Jkt.
J.L. Abdul Muis 62
JAKARTA
Tel: 373009
Telex: 46748 BERSAL IA
Cable: BERSAL
A,E,M,P
BERCA Indonesia P.T.
J.L. Jimento 23
SURABAYA
Tel: 42027
Telex: 31146 BERSAL S.D.
Cable: BERCACON
A*,E,M,P

IRAQ

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BAGHDAD
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Telex: 2455 HEPAIRAQ 1k
CP

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DUBLIN 2, Eire
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Telex: 30439
A,E,P*
Hewlett-Packard Ltd.
2C Avonberg Ind. Est.
Long Mile Road
DUBLIN 12, Eire
Tel: 514322, 514224
Telex: 30439
A*,CP,E,MS,P*
Cardiac Services Ltd.
Kilmore Road
Artane
DUBLIN 5, Eire
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M

ISRAEL

Electronics & Engineering Div.
Motorola Israel Ltd.
16 Kremenetski Street
P.O. Box 25016
TEL-AVIV
Tel: 338973
Telex: 33569
Cable: BASTEL Tel-Aviv
A,CM,C,E,M,P

ITALY

Hewlett-Packard Italiana S.p.A.
Via Martin Luther King, 38/III
I-40132 **BOLOGNA**
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Telex: 511630
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Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio 9
I-20063 **CERNUSCO SUL NAVIGLIO**
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Telex: 334632
A,CM,CP,E,MP,P
Hewlett-Packard Italiana S.p.A.
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I-80135 **NAPOLI**
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Hewlett-Packard Italiana S.p.A.
Via Turazza 14
I-35100 **PADOVA**
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Telex: 430315
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Hewlett-Packard Italiana S.p.A.
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I-00143 **ROMA**
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Telex: 610514
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Hewlett-Packard Italiana S.p.A.
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Yokogawa-Hewlett-Packard Ltd.
Kumagaya Ashai Building
4 Tsuchikuba, 3-chome
KUMAGAYA, Saitama 360
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CM,CS,E
Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Building
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Yokogawa-Hewlett-Packard Ltd.
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Telex: 232-2024 YHPTOK
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YOKOHAMA, Kanagawa 221
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Telex: 382-3204 YHP YOK
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AMMAN
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Telex: 21456 SABCO JO
E,M,P

KENYA

International Aeradio (E.A.) Ltd.
P.O. Box 95221
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M
ADCOM Ltd., Inc.
City House, Wabera Street
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NAIROBI
Tel: 331955
Telex: 22639
A*,E,M
International Aeradio (E.A.) Ltd
P.O. Box 19012
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NAIROBI
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M

KOREA

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Telex: SAMSAN 27364
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KUWAIT
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A,E,M
Photo & Cine Equipment
P.O. Box 270 Safat
KUWAIT
Tel: 42-2846, 42-3801
Telex: 2247 Matin
P

LUXEMBOURG

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Telex: MA 70904 PROMAL
Cable: PROTELENG
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Hewlett-Packard Mexicana, S.A. de
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CS

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Tel: 3041-82, 3068-38
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E
Gerep
2 rue d'Agadir
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CASABLANCA
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Telex: 23 739
P

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Tel: 461577
Telex: 31231 TEIL NG
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P

PAKISTAN

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A,E,M,P
Mushko & Company Ltd.
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Telex: 2894 MUSHKO PK
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SALES & SUPPORT OFFICES

Arranged alphabetically by country

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A,E,M,P
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P

PERU

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Telex: Pub. Booth 25424 SISIDRO
Cable: ELMED Lima
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Legaspi Village, Makati
P.O. Box 1510
Metro **MANILA**
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Telex: 3274 ONLINE
A,C,E,M
Electronic Specialists and
Proponents Inc.
690-B Epitanio de los Santos
Avenue
Cubao, **QUEZON CITY**
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Tel: 98-96-81, 98-96-82, 98-96-83
Telex: 742-40287
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5



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